

LIVELIHOOD DIVERSIFICATION AND SUSTAINABILITY:
UNDERSTANDING FISHING, FARMING AND RESOURCE MANAGEMENT IN
THE SENEGAL RIVER DELTA

A Dissertation

by

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ABSTRACT

Over the past three decades scholars and practitioners have looked to livelihood diversification as a strategy for sustainable resource exploitation and improved wellbeing. Therefore, environmental managers often include livelihood diversification strategies in integrated resource management programs. However, as the success rate of these approaches falls short of expectations, questions about the conditions under which they generate and sustain positive outcomes have become critical. The goal of this study is to address some of these questions using the case study of three communities in the transboundary biosphere reserve of the Senegal River Delta, in Senegal and Mauritania. Specifically, it focuses on the combination of fishing, farming and resource management policies as a mechanism to facilitate the emergence of sustainable resource exploitation and improve local livelihoods.

The research objectives include understanding: 1. The institutional and socio-economic factors that help create the conditions for sustainable resource exploitation. 2. The contribution of farming in fishing livelihoods. 3. The processes that enable men and women in fishing communities to participate in farming activities. The fieldwork was conducted over a period of 11 months in 2013-2015. Qualitative and quantitative data were gathered using multiple data collection methods, including household surveys, semi-structured interviews, key informant interviews and participant observations.

The study demonstrates that integrated resource management plans must design institutions that create a consensus and a sense of resource ownership among resource

users, and provide support for local livelihoods. It also indicates that diversification intervention that focuses on enhancing already existing livelihood strategies, rather than introducing new ones (e.g. ecotourism), can be more effective at strengthening the conditions for sustainable resource exploitation. Furthermore, the findings provide evidence that the economic contribution of women to the household influences decisions about fishery resource exploitation. Therefore greater effort should be put in place to enhance the economic contribution of women in fishing communities, taking into account gender-based limitations such as access to farm labor and organizational capacity. Furthermore, building livestock assets and improving access to land, credit and technical knowledge can also serve as mechanisms to strengthening the socio-economic conditions for sustainable resource exploitation and improve the livelihood security of fishing communities.

DEDICATION

My parents, Yvonne and Pape Sène Diery are firm believers that all educational and professional achievements must serve as stepping-stones for future generations.

Therefore, I dedicate this doctoral thesis to the next generations of the Sène, Harper and Scott families. May this work be the foundation of many lofty achievements for generations to come. May all our future great works serve our family, communities and African people as a whole.

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NOMENCLATURE

CH	Commercial Horticulture
DPN	Direction des Parc Nationaux
DNBP	Djoudj National Bird Park
DNP	Diawling National Park
FAO	Food and Agriculture Organization
GIRMAC	Gestion Intégrée des Ressources Marines et Cotières
HH	Households
MEDD	Ministère de l'Environnement et du Développement Durable
PNOD	Parc National Des Oiseaux du Djoudj
PND	Parc National De Diawling
SLF	Sustainable Livelihood Framework
UEMOA	Union Economique Monétaires des Etats de l'Afrique de l'Ouest

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CHAPTER I

INTRODUCTION

1.1. Introduction

The resources of many lakes and rivers around the world provide benefits that are vital to humans and migratory bird populations. The livelihoods of millions of people in rural communities throughout Africa depend directly on inland fisheries (FAO, 2013). These fish resources are also the primary source of food for the rich bird populations that prey on them (Cowx, 2003). The Senegal River Delta in Senegal and Mauritania is one of those areas that have attracted the attention of many NGOs because of its importance for the livelihoods of fishing communities and the millions of Eurasian and African migratory birds.

The significance of this region in terms of biodiversity conservation prompted the governments of Senegal and Mauritania to establish six different protected areas covering 600,000ha, which in 2005 all became part of the Transboundary Biosphere Reserve of the Senegal River Delta. However as in the case of many countries throughout the world, the fish populations of this river system are under serious threat of rapid decline (Magrin & Seck, 2009). Environmentalists have attributed the depletion in fish stocks primarily to ecological mutations resulting from the construction of two dams in the 1980s. (Borrini-Feyerabend and Hamerlynck, 2010). Additionally, in recent years, the growing human populations in the Senegal River Delta (SRD) has led to an increase in fishing pressure (Ministère de l'Environnement et du Développement Durable

[MEDD], 2013). As a result, there is a growing concern among resource managers that the unsustainable fishing activities will further deplete fish stocks in the Senegal River thereby impacting livelihoods and the bird populations (Ndiaye, 2001).

The degradation of fish resources in the Senegal River is a critical issue for both conservationists and development practitioners working in the area. According to the Department of Inland Fisheries in Senegal (2013) an estimated 26,000 people depend directly on the fish resources of the river systems. Fall *et al.* (2003) explain that resource degradation combined with conservation policies has also negatively impacted the livelihoods of fishing communities in the area. Furthermore, the Ministry of Environment and Sustainable Development reported in 2012, that these fish resources are the primary source of food for over 122 species of birds in the biosphere reserve alone. Therefore, implementing strategies to reduce the unsustainable exploitation of fish resources, and improving the livelihoods of fishing communities have been the priority of resource managers in SRD (Ndiaye, 2001; DPN, 2010; MEDD, 2013).

Since 1994, the governments of Senegal and Mauritania have partnered with several international NGOs to implement different integrated resource management plans for the biosphere reserve. The goals of these plans have been to alleviate fishing pressure and reduce the level of poverty in the fishing communities around the reserve (DPN, 2010). The integrated management plans have generated positive outcomes in some communities. However, the impacts are very limited (DPN, 2010). For most fishing communities around the reserve, unsustainable fishing practices continue to be a major challenge and households are still grappling with high levels of poverty (Borrini-

Feyerabend and Hamerlynck, 2010). Technical reports also show that there continues to be a decline in fish stocks in SRD combined with declining migratory water bird populations (Ndiaye, 2001; DPN, 2010; MEDD, 2013).

As such, there is an urgent need for more carefully designed integrated fishery management plans that are based on a better understanding of local livelihood strategies. Therefore, the motivation for this project is to inform holistic resource management policies on: what influences fishers' decisions about resource exploitation, the determinants of the livelihood diversification outcomes in fishery systems, and the social processes embedded in local economic diversification strategies. As such this study can help resource managers understand how these factors and processes can best accommodate sustainable livelihood projects for biodiversity conservation and community development.

The scholarship on rural livelihoods and natural resource management advances several theories that serve as point of departure for this study. First, Chambers and Conway (1991) explain that one of the root causes of resource degradation in rural communities is the households' vulnerability to environmental and economic changes. Poor rural households face difficult decisions as they try to adapt to natural resource fluctuations. The decisions embedded in these adaptation strategies influence how they exploit their natural resources (Davies, 1997). Béné *et al.* (2009) draws parallel conclusions in their studies on chronically poor communities of river fisheries in Congo, where households relied extensively on fishing resources to maintain their wellbeing when changes occur. Scholars also maintain that by enhancing their livelihood security,

households become less vulnerable to resource fluctuations, which in turn can reduce their dependence on natural resources (Chamber 1989; Frankenberg *et al.*, 2000, Bhandari & Grant, 2007). Therefore, African river fisheries can be sustained partially through the achievement of livelihood security in fishing communities.

Livelihood diversification is a crucial adaptation strategy for rural households that often lead to livelihood security (Ellis, 2000; Allison & Horeman, 2007). There is a clear recognition that this strategy is an integral component of sustainable fishery systems (Morand *et al.*, 2005; Olale & Henson, 2013; Matera *et al.*, 2016). When fishery resources are scarce, households engage in diverse economic activities to access income from alternative sources and allow fish stocks to recover (Cinner *et al.*, 2009). Thus, in the last two decades integrated fishery management plans, particularly in Africa and Asia, have promoted livelihood diversification to reduce fishing pressure while improving the welfare of fishing households (Hill, 2005; Burgère *et al.*, 2008).

Nonetheless, according to Sarch and Allison (2001), management plans should be based on local livelihood strategies that evolved from responses to local environment and broader social contexts. In SRD, most fishing households complement their livelihoods with farming activities. Geheb and Binns (1997) explain that farming production in fishing communities is an adaptation strategy that has proven to be resilient to fisheries resource fluctuations. While, for a long time, program managers in SRD overlooked this important aspect, over the past decade they have been paying more attention to farming as a strategy to achieve livelihood security and facilitate the emergence of sustainable resource exploitation in the reserve. Therefore, this project

focuses on the participation of fishing households in farming production as a livelihood diversification strategy in the communities around the reserve in SRD.

Even though program managers look to livelihood diversification as a strategy for sustainable fishery systems, such programs have had limited success (Brugère et al., 2008). Part of the reason is that livelihood diversification alone does not always translate to lower fishing pressure (Hill *et al*, 2012). Therefore, Seivenan *et al.* (2005) believes that livelihood diversification, as a means to reduce fishing pressure should be combined with fishing institutions to regulate resource exploitation and meet fishers' needs.

Program managers in SRD have relied on fishing regulatory institutions and diversification projects to manage the reserve. However, these institutions differ in both Senegal and Mauritania, yielding different forms of fisheries exploitations.

Thus, one of the goals of this project is to understand the factors embedded in the diversification process and institutions instituted in these communities that help explain the different forms of fisheries exploitation resulting from these management plans. This can help explain how diversification and fishery institutions can best be integrated in the livelihoods to regulate the pattern of fishing activities. Therefore, the motivation for this project is to generate knowledge that can inform integrated fishery management plans on:

- What institutional and household level factors influence fishers' decisions about how to exploit fishery resources?
- The effects of livelihood diversification on the livelihood security of fishing households.

- The social processes that shape how men and women in fishing communities engage in livelihood diversification.

I believe this study can help resource managers understand how these factors and processes can best accommodate sustainable fishing livelihood projects.

1.2. Livelihood Diversification

Ellis defines livelihood diversification as the “process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standard of living” (1998, p. 4). In this definition, livelihood is not understood merely as a source of income, but also comprises the tangible and intangible assets that people have in their possession to build livelihood strategies, the institutional processes that mediate access to those resources and the outcomes of diversification (Chambers, 1983; Ellis, 1998, 2000; Scoones, 1998). As such, following this perspective, studies and conceptual writings on this subject has tended to focus on the determining factors of livelihood diversification, the types of activities adopted by various social groups, and the outcomes of this strategy for subsistence.

The diversification process among rural households entails the adoption of different types of activities grouped in the literature as either farm or non-farm activities. For farm activities, agricultural and livestock goods and services are utilized to generate revenue for the households (Hussain & Nelson, 1998). Non-farm activities comprises all non-agricultural and livestock activities, which generate income for rural households

either through waged work or in self-employment (Davies, 2003). Research shows that many pastoral groups in Sub-Saharan Africa tend to diversify into agriculture (Agrawal 2008; Little et. al, 2001; McCabe, 2003) but are also increasingly adopting off-farm activities through wage employment especially in the tourism industry (Homewood et al., 2009). There are also studies reporting the adoption of on-farm activities among fishermen. This is particularly the case for sedentary groups in the African inland fisheries where small-scale fishermen are pursuing crop cultivations to supplement their income especially during the season when fish stocks are low (IMM. et al., 2005; Morand et al., 2005; Sarch & Allison, 2000).

The development literature has tended to classify the determining factors of livelihood diversification in two broad categories. Ellis (2000) refers to these two categories as push and pull factors, denoting the necessity or choice of households to adopt complementary activities at a given point in time. Barrett et al. (2001) explains that pull factors can be understood as opportunities for rural households to diversify their activities, whereas push factors can be seen as constraints that force them to adopt alternatives. Push factors include conservation policies, climatic variations and unfavorable political economic environment (Baird and Leslie, 2013; Davies, 1996; Agrawal, 2008). For example, seasonality forces households to engage in alternative activities that are congruent with cyclical periods associated with primary livelihoods sources. On the other hand, pull factors include any positive changes that provide households with the opportunity to accumulate revenue. For example, positive market

trends of a particular economic activity could motivate rural households to diversify - and thus increase their level of income (Ellis, 2000).

A number of sources concur that the capacity of rural households to diversify their income sources is critical for their survival (Ellis, 1998; Ellis & Allison, 2004; Davies, 1996; 2004). Factors that contribute or hinder the capacity to diversify have been found to be either related to their ability to access and utilize their economic, natural and physical resources, or their level of human capital. First, in relation to economic and physical assets, access to land is perhaps the most crucial factor for households to be able to diversify their revenue (Ellis & Allison, 2004). The landless poor is found to be the least capable to adopt supplementary activities and thus the most vulnerable to seasonal and risk factors (Davies, 1996; Ellis, 2000; Ellis & Allison, 2004). Limited access to land, results in a greater dependence on natural resources used for traditional activities such as fishing and herding. An important physical asset playing a vital role in the diversification process includes livestock because some households in non-pastoral groups own a few heads for trading purposes (Barrett et al., 2001). In regards to the human and social capital of the household, Ellis (2000) states that human capital, particularly education and vocational skills, is widely substantiated as a key to successful livelihood diversification. Finally, Nygren and Myatt-Hirvonen (2009) found networks to be a vital social capital among rural households.

Several studies revealed the social and economic benefits of livelihood diversification. For example, in relation to food security, Block and Webb (2001) reported that after the famine in Ethiopia households with a more diversified activity

portfolio had a higher food consumption rate than those who significantly relied on their primary livelihood activity. McCabe (2003) demonstrated that the adoption of agriculture by Maasai pastoralists in Tanzania played an important role in their capacity to adapt to the increasing cash economy without having to give up a significant number of cattle. In addition, Baird and Leslie (2013) found that households in proximity to the Tangarine National Park in Tanzania were more likely to diversify their sources of income beyond agriculture and pastoralism. As a result, they were able to reduce the impacts of the protected area, which drastically curtailed their access to vital resources, on their wealth and income. Finally, Béné et al. (2003) found that in wetland and floodplain areas of West Africa, where fishing are recognized to constitute a key element in the local economy, cultivation contributes a larger portion in the overall household income even though more time is spent on fishing activities.

While the impacts of livelihood diversification on the social and economic well being of rural households have become clearer, the environmental impacts are more elusive. Ellis and Allison (2004) maintain that livelihood diversification can relieve the pressure of off sensitive natural resources; however, there has been little research to empirically support such contention. Most studies on the effects of income diversification on natural resources are carried to evaluate integrated conservation and development projects in which reducing the environmental impacts of livelihoods is the principle goal of such programs (c.f. Belcher et al., 2005; Mbawai, 2008; Parker, 2009). In these cases, alternative sources of income were implemented in the rural communities by mostly environmental NGOs or governmental agencies. However, the environmental

impacts of livelihood diversification strategies emerging from within communities remain under-explored. As household level diversification is widely recognized as an inherent and important feature of rural livelihoods and leads to the resiliency of various social groups (i.e. fishermen, pastoralists and farmers), understanding its influences on natural resource exploitation is also critical for designing sustainable development projects in rural areas.

In fishing communities, Allison and Ellis (2001) claim that diversification among fisherfolks is a characteristic of the “sustainable” fishery systems by taking the pressure off of fishing resources. Alternative livelihood activities give the capacity to fishermen to make up the income foregone from fishing activities during the biological reproduction season. Seivenan et al (2001) found some evidence in this contention in their study on the impacts of diversification through seaweed farming in coastal Cambodia. The results of their study showed a little change in overall fishing effort where seaweed farming was carried alongside farming, but a decline in seaweed farming was inversely correlated to an increase in fishing pressure. In this same study they also found that commercial fishing had declined in areas where fishing was complemented with seaweed farming. However, Pauly (2005) argues that income generated through complementary non-fishing activities can be used to invest in unviable fishing technology thereby accelerating the decline of fish stock. Nevertheless, Brugère et al. (2008) explain that there are no sufficient studies that reveal the direct impacts of supplementary economic activities on fishing efforts, in order to substantiate any of these contentions.

Within the literature on livelihood diversification, there are aspects that remain unclear because of limited research. First, there are not enough studies that evaluate the conditions under which livelihood diversification lead to sustainable resource exploitation. Second, very few studies have looked into the process of adoption of cultivation by small-scale fishermen and its effects of their livelihoods. As such, the proposed study, through all its research questions, will examine these issues that the literature has tended to overlook.

1.3. Integrated Resource Management

Over many decades, environmentalists implemented resource management and conservation policies that excluded local communities who livelihood depended on those resources. (Adams *et al*, 2004). Hoole and Berkes (2010) explain that such conservation strategies tended to decouple human systems from their natural systems and local communities were denied access to resources. Ample research has been conducted to provide evidence of the negative impacts of exclusionary resource management approaches on the local communities (c.f. Irandu, 2004; Nelson & Agrawal, 2008, Van Damme & Meskell, 2009, Bunce, Brown & Rosendo, 2010). Furthermore, such strategies proved to be counterproductive as species continue to decline (Adams *et al*, 2004). As a result, since the late 1980s, there's been a paradigm shift towards integrated resource management approaches that take into account both environmental and development goals (Gibson & Agrawal, 1999; Letvak & Seddon, 1999; Borrini-Feyerabend *et al.*, 2007)

Integrated resource management approaches address issues associated with environmental degradation through broadly use of socio-economic incentive mechanisms as strategies to foster resource stewardship among local communities (Alpert, 1996). Incentives are typically provided to local people in the form of economic derived from ecotourism revenues, limited harvesting of plant and animal species, or provision of community facilities in exchange of community support for conservation (Newmark & Hough, 2000; Stronza, 2007). Agrawal & Redford (2006) explain that there are different forms of integrated approaches to resource management and conservation. Therefore, they have different names attached to them (i.e. co-management systems, community-based natural resource management, community-based conservation, integrated conservation and development projects).

Nonetheless, scholars have argued that in many cases, economic incentives alone are not enough to generate pro-conservation behaviors (Stronza & Pegas, 2008). The participation of local communities in the decision-making process about resource management is also a critical factor (Ribot, 2004). Consequently, integrated management approaches also entails restructuring the institutional field to provide a legitimate space for local communities to actively participate in all aspects of the management of natural resources (Gruber, 2010; Campbell & Viana-Mattilo, 2003).

As the success record of these programs fell short of expectation, questions about why some work and others don't, have been central to ample empirically based research. Such questions have been approached by some scholars who examined the institutions embedded in different projects (c.f. Nelson & Agrawal, 2008; Poteete & Ribot, 2011),

while others looked at the underlying assumptions of many forms of integrative approaches (c.f. Agrawal & Gibson, 1999; Agrawal & Redford, 2006; Campbell & Vianio-Mattila, 2004; Ellis, 2004).

Armitage (2005) explains that a weakness of integrative approaches, such as community-based natural resource management, is that they fail to account for changes that are specific to their context. According to Cash et al (2006) macro-level changes have impacts at the local level, and cause people to constantly readjust their strategies in ways that can change the direction of conservation programs. The diversification of livelihoods is a very common adaptation strategy that adds an element of complexity into rural livelihoods (Allison & Horemans, 2006). Additionally, Toillier et al. (2011) find that the livelihood heterogeneity is also an important aspect that integrative approaches underplay. For example, fishing livelihoods are fundamentally cross sectoral in character but integrative approaches are almost always sectoral in conception (Allison & Ellis, 2001). This study intends to bring forth the different livelihood strategies of fishing households in three communities in proximity to the biosphere reserve of the Senegal River Delta. I study particularly the uptake of farming activities by fishing households as a livelihood diversification strategy and its implications on the integrated managements plans of the two main protected areas located in the reserve.

1.4. Objectives

This project aim is to understand how livelihood diversification can best be combined with resource management institutions to promote sustainable resource

exploitation in fishery conservation areas. The study seeks to unveil factors that influence fishers' decisions about resource exploitation and the effects of diversification on fishing livelihoods. Four research questions guide this dissertation research. These are presented below.

1. What institutional factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation?
2. What socio-economic factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation?
3. What factors help explain why diversification enhances the livelihood security for some fishing households but not for others?
4. How do men and women in fishing communities organize their social relations to access the resources they need in order to diversify their livelihoods?
5. What social structures shape fisherman and women participation in farming activities as a diversification strategy?

1.5. Significance of Study

I believe this project is significant because of the following reasons:

1. The results will enhance our current knowledge about the relationship between livelihood diversification and sustainable resource management, particularly within the context of fisheries.

2. This study provides knowledge on the conditions that leads to an effective integration of livelihood diversification and regulatory institutions for sustainable inland fishery systems.
3. This study helps us better understand how livelihood diversification contributes to the livelihood security of fishers.
4. The results provide some insight into the factors that explain why diversification enhances the livelihood security of some fishing household but not others.
5. This study helps understand how local sustainable livelihood projects can best be integrated with local level processes and how to address the conditions that are problematic to inland fishing communities in Africa.

CHAPTER II

METHODOLOGY

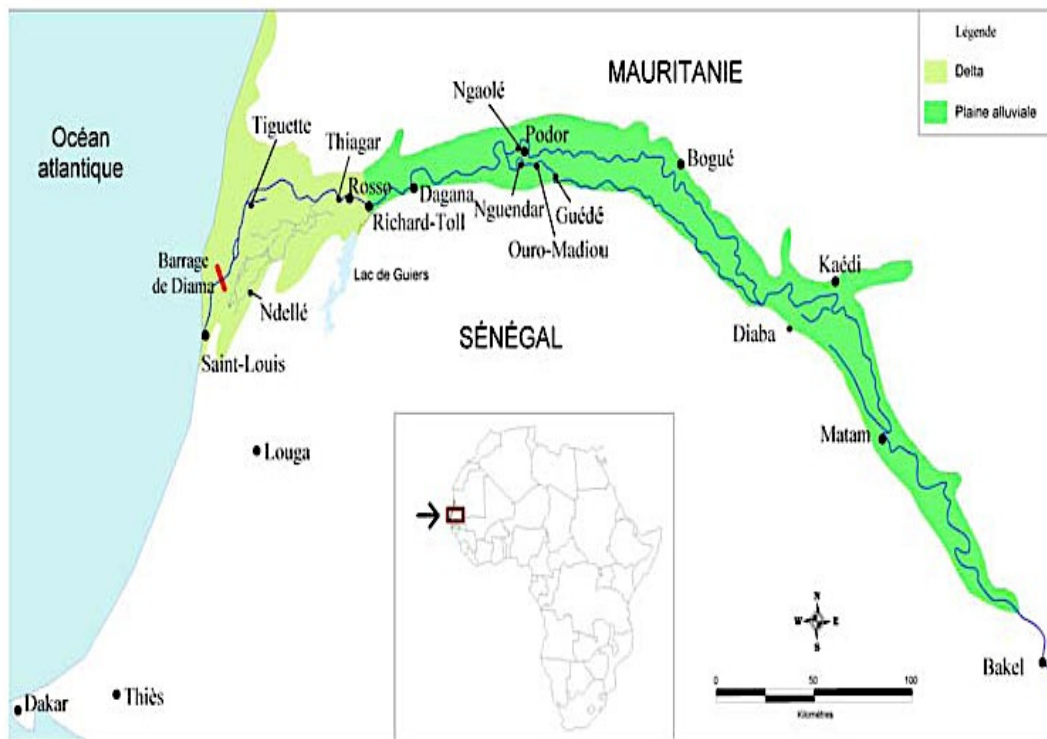
2.1. Study Area

2.1.1. Geographical and historical context

The study was carried in the Senegal River Delta (SRD) located in the Sahelian drylands of West Africa (Figure 1). The climate in the region is characterized by two main seasons: a dry season that ranges from November to June. The rainy season extends from July to October, however its annual precipitation rates have been consistently decreasing. As such, severe droughts are prominent in the region (DPN, 2010).

Despite the changing climatic conditions of the region, the Senegal River is crucial to the national economies and biodiversity of a wide region of West Africa, including Mauritania, Senegal, Mali and Guinea. Because of its changing conditions and its relevance for the region, starting in the early 1970s, resource managers put environmental and economic policies into effect in an attempt to preserve the important dualistic role of the Senegal River. These policies lead to significant and irreversible changes to the region's social and ecological landscapes thereby causing shifts in livelihood practices for various social groups including fishers.

Figure 1. The Senegal River Delta.



Source: Le Roy *et al.* (2005)

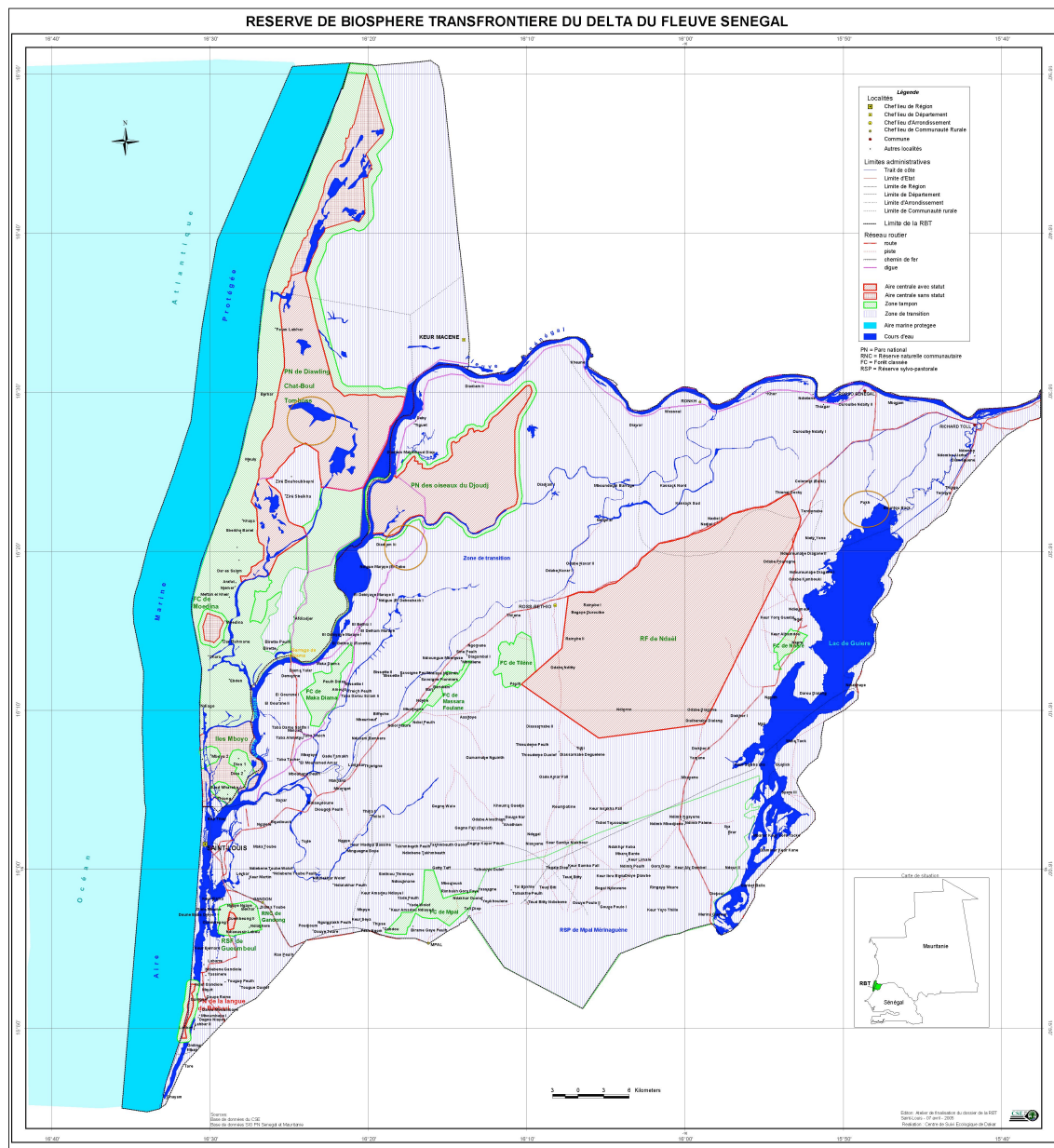
Over the past 5 decades the area has been the target of conservation policies, materialized in the creation of multiple protected areas and natural reserves. The main reasons for resource managers to implement these conservation policies were to protect the important population of migratory birds, maintain a steady fish stock, and restore the wetland's ecosystems. In 2005, all of these protected areas and reserves became part of the Transboundary Biosphere Reserve of the Senegal River Delta, a UNESCO world heritage site. Today, the biosphere reserve covers 600,000 hectares of ecosystems

(terrestrial, lake, river, estuarine and marine-coastal) of great social and ecological values (Borrini-Feyerabend, 2010) shared between Mauritania and Senegal.

The two largest protected areas of the reserve are the Diawling National Park in Mauritania and Djoudj National Bird Park in Senegal (see Figure 2). These parks have different management systems. In Mauritania, the national park is managed through a concession system including territorial fishery units that are co-managed between the government and the local communities. In Senegal, the system is more exclusionary as the government is in charge of managing the resources inside the protected limits and the participation of local communities is very limited.

It is important to note the contrasting approaches in which the two countries have chosen to manage the resources in their side of the reserve. This difference is reflective of the history of conservation in both countries. The histories of these two countries show that French colonization was (and still is) more influential in Senegal than in Mauritania. This is reflected in the way each country has and continues to govern its natural resources. Following a fortress conservation model that dominated the global scene, the government of Senegal established the Djoudj National Bird Park (DNBP) in 1971, a core area of the reserve covering 16,000 hectares. Since the 1950s, the conservation of natural resources in Senegal rests on an authoritarian paramilitary regime instituted by the French colonial government. A paramilitary body manages all protected areas in Senegal, including DNBP.

Figure 2. Transboundary Biosphere Reserve of the Senegal River Delta



Source: Centre de Suivi Ecologique, n.d..

Mauritania, however, became engaged in the biodiversity conservation movement almost two decades after it gained its independence from France. It was in 1991 that Mauritania established the Diawling National Park (DNP), the second core area of the biosphere reserve of SRD. The establishment of DNP happened during a period of paradigm shift in the global conservation movement, forcing resource managers to move away from exclusionary models to become inclusive of local communities and consider development in concert with conservation goals. The management of DNP fell in line within this newer and more inclusive approach.

In addition to these conservation policies, the government of Senegal and Mali built the *Diama* and *Manantali* dams in the Senegal River, which were completed in the 1989. The two dams have had severe negative impacts on the ecosystems, including the intrusion of invasive aquatic vegetation, lower level of water, and changes in water flow regime, thereby reducing the fish stock in the river systems and connected flood plains (Magrin & Seck, 2009; Ndiaye, 2001). Despite the conservation policies put in place and the ecological changes on the river system, the area continues to be the main supplier of small-scale fish markets in the major cities of the SRD such as Saint-Louis and Richard-Toll (Magrin & Seck, 2009).

The conservation policies combined with the ecological mutations of the Senegal River have drastically curtailed fishers' access to important fishing grounds. As a result, fishing households have had to adjust their livelihood strategies in order to adapt to these changes. In the following section I provide an overview of the evolution of livelihood strategies in the fishing communities of the SRD.

2.1.2. Shifts in local livelihoods

Fishing, agriculture and herding, which are heavily dependent on the natural resources of the region, constitute the most important traditional forms of subsistence and income generation in the SRD. The changes described above led local people to engage in different pathways in search of sustainable livelihoods. Over the years, fishers around the biosphere reserve, both in Senegal and Mauritania have established their own livelihood strategies through economic diversification. As such, commercial horticulture (CH) has become an increasingly important source of income for fishers in the region, which is expanding primarily through community-level processes. Commercial horticulture, also called market gardening, is the production of fruits and vegetables as cash crops on a parcel that is typically less than 2 hectares. In the early 1970's rice production used to play an important role in the livelihoods of traditional fishers in the DSR, however this role continues to decline due to climatic variations and economic policies unfavorable to smaller producers, slowly giving way to commercial horticultural activities. Today, commercial horticulture, hold an important position in the livelihood portfolios of traditional fishers and serve as an alternative source of income during low fishing season.

Unlike rice production, the commercial horticulture season is congruent with the seasonal variation in fish resources. The ideal fishing season occurs at the start of the rainy season in August and continues throughout the colder months all the way to February. Fish stocks are at the lowest when temperatures are high from April through July. April to July is the reproductive season for most fish species. During this time,

mature fish migrate to other areas or go underground to reproduce, leaving in the surface mostly juvenile fish. This period is very critical in the fish life cycle, and the intensity of fishing activities during this time will have a significant impact on fish stocks in the future (Pandare & Sanogo, 1996). Therefore, it is considered unsustainable to intensify fishing efforts in the Senegal River system from April to July (Pandare & Sanogo, 1996). Commercial horticulture season starts as early as November and can be harvested starting in April until the end of July. Throughout these months, commercial horticulture provides an alternative source of income to fishers when fish stocks are low. In both protected areas in Senegal and Mauritania, there are strict regulations to limit commercial fishing during the low season. For this reason, resource managers, particularly in Mauritania are looking up to commercial horticulture as a potential strategy to reduce commercial fishing from March to July by providing fishing households with an alternative source of income.

For the purpose of the study, we have selected three villages that are located around the biosphere reserve, two located in Senegal, *Diadieme* and *Bountou Batt*, and one in Mauritania, *Zire Taghredient*. The black Moors make up the predominant ethnic group in all three villages, followed by the Wolof who settled in the region more recently. These two ethnic groups control fishing and agricultural activities in the region (Fall et al., 2003). All three localities primarily consist of traditional fishers who complement their fishing income from agriculture and livestock. Table 1 provides a summary of relevant characteristics of each community.

Table 1. Characteristics of study communities

Characteristics N= 104	Zire (Mauritania) n =40	Diadieme (Senegal) n=44	Bountou Batt (Senegal) n=20
Population	~540	~693	~300
Number of Households	95	110	47
Ranking of economic activities	<ol style="list-style-type: none"> 1. Fishing 2. Commercial horticulture 3. Livestock 	<ol style="list-style-type: none"> 1. Fishing 2. Rain-fed rice production 3. Commercial horticulture 	<ol style="list-style-type: none"> 1. Fishing 2. Commercial horticulture 3. Rain-fed rice production

Source: MEDD (2013), DPN (2010; 2015)

These three communities were chosen because of the different fisheries management systems and diversification processes that have yielded different forms of fisheries exploitation across all three localities. In Mauritania, where Zire is located, fishers' have concession rights to fish within the community territorial unit inside the protected area. Whereas in Senegal, fishers only have access to the buffer zones, and fishing inside the protected area is strictly prohibited. We discuss in more detail the protected area management systems and how fishers in each community respond to these regulations in the chapters. The variations in the way they diversify their livelihood and the fishery management systems allows me to compare and contrast the outcomes in each community and unveil key elements in the process.

2.2. Data Collection and Analysis

Preliminary fieldwork was carried during the months of April through August 2014. During those months, I visited several small-scale fishing villages around the transboundary biosphere reserve of DSR both in Senegal and Mauritania where farming operations are also taking place. The purpose of those visits was to understand the livelihood strategies of fishing households including their different sources of income, the resources available and the issues they face. All this information was collected via focus groups and open-ended interviews with key informants and community members. During the focus groups and interviews, the residents were asked to discuss the following major points:

- How they made a living throughout the year and their most important sources of livelihood;
- The issues they faced to maintain or improve their well-being and the resources they have to support them;
- Their relationship with officials of the biosphere reserves;
- Their perceptions about the reserve management system.

Information about the current fishery management systems for the protected areas was also collected. Park officials were interviewed about the challenges they faced with the local communities and the different projects that were implemented to resolve these issues. I also interviewed NGOs officials who were in charge of the different livelihood projects to gather their opinion about the challenges they faced in these communities.

After the preliminary fieldwork, I returned to the site to collect data from March-June, 2015. The data collection methods were both qualitative and quantitative targeting 104 households. When the head of household was not present, the spouse was interviewed, which happened in 17/104 times. Purposive sampling was used to target households that mentioned fishing and farming as first and second most important sources of income.

The data collection process consisted of two steps. First, some baseline information was gathered on household member's main economic activities, revenue from fishing and farming, material wealth (e.g. fishing gears, livestock) and household expenditures (e.g. what are their priorities in choosing how to spend their farming and fishing income). This information was collected using close-ended questions from which I derived most of the quantitative data. Second, semi-structured interviews followed and included questions about:

- Head of the household perceptions on their livelihood security;
- How farming contributes to the household livelihood security;
- Income pooling among household members;
- Organization of labor;
- How the household access the resources needed to farm.

In addition to the household interviews, I included open-ended questions for the 17 women who participated in this study and 3 leaders of women associations. The purpose of these questions was to understand the major limitations they faced as they try

to participate in diversifying their economic activities, their participation in farming production and their work in collective settings with other women in the community.

The data was complemented with informal conversations with community members, participant observation, and secondary data from technical reports and governmental documents. Most interviews with fishers were conducted by me in Wolof (the main local language), or in Moorish (spoken by the Moors) with the help of a local translator who was recruited from the village. The translation happened from Moorish to Wolof. All interviews with governmental field technicians were conducted as well by me in French. I am fluent in Wolof and French.

The qualitative data was analyzed through a directed content-analysis approach (Hsieh and Shannon, 2005), which allowed the analysis and interpretation of data guided by the concepts under study (defined by the research questions and detailed in each of the articles included in this dissertation). Using this approach, the concepts under study are used to guide the initial coding. However, during the data analysis, the researcher allows underlying themes to emerge from the data for a deeper analysis of these concepts (Hsieh and Shannon, 2005). The quantitative data was analyzed using basic statistical tools on Microsoft excel. Most of this data was descriptive and used to calculate average farming revenue per household, frequencies and percentages.

Each interview was translated from Wolof to English and transcribed by me. As I reviewed each interview, a summary table was created listing the different concepts under study (livelihood security dimensions). For each concept, the different associated sub-themes that emerged during the interview were listed. These were reported in the

finding sections indicating which were more commonly reported. The process was repeated for each community. Separating the data from each community allowed a comparison to be carried in order to reveal the contextual factors that could help explain the results. To ensure trustworthiness were achieved we used reflexivity (Guba & Lincoln, 1989). Reflexivity was achieved by contrasting the sub-themes with field notes from participant observation and informal conversations with community members. We also contrasted the data from the interviews with fishers with the information that emerged through our unstructured interviews. There was consistency between these sub-themes and the data collected from participant observations and informal conversations and across the unstructured and semi-structured interviews. Additionally, secondary data was used to help corroborate some of these findings and gain contextual understanding of the communities. These included technical reports, past studies carried in the region and studies on inland fisheries in West Africa.

2.3. Study Limitations

The major limitations of this study include:

1. Not having included a second community on the Mauritania side of the biosphere reserve is a major limitation. Including a second community would have allowed this study to
2. corroborate my data and provide more validity to our results. However, a second community in Mauritania will be considered for future research.

3. Insecurity due to political and social unrest in the southern region of Mauritania was the main reason why I was not able to travel to another community in the area.
4. Limited time and budget were the biggest constraints in this study. For instance, I was not able to spend more time into these communities to collect more data through participant observation.
5. Transportation was also a major limitation. Moving from one community to another required careful planning and coordination with field technicians. During the rainy season, the roads are impracticable and it has pushed

CHAPTER III

FISHERIES INSTITUTIONS, LIVELIHOOD DIVERSIFICATION AND SUSTAINABLE RESOURCE EXPLOITATION IN THE SENEGAL RIVER DELTA

3.1. Overview

Scholars have long advocated combining fisheries management institutions and livelihood diversification to strengthen the conditions for sustainable resource exploitation. However, very few studies have examined integrated management plans that have taken such an approach and the conditions under which they would lead to sustainable resource exploitation. In this paper, we seek to better understand the factors that strengthen the social and economic conditions for sustainable fisheries exploitation when management institutions and livelihood diversification are combined into one integrative approach. We use the case studies of two fishing communities, one on each side of the Transboundary Biosphere Reserve of the Senegal River Delta in Senegal and Mauritania. Each country has implemented a distinct integrated management plan, which has yielded different forms of fisheries exploitation.

Our study shows that co-management institutions based on a concession style create a sense of resource ownership and consensus among fishers, both of which are factors known to promote resource stewardship. Additionally providing institutional support for local livelihood strategies was also crucial in positively shaping fishers behaviors. Furthermore, livelihood diversification strategies can create conditions for sustainable resource exploitation when they are congruent with household needs and

when household income is sustained through women's financial contribution. Finally, diversification interventions that focus on enhancing already existing livelihood strategies are more effective at creating conditions for sustainable resource exploitation.

3.2. Introduction

The rapid decline in fishery resources over the past several decades has generated great amount of scholarship seeking to understand ways to balance fisheries conservation with social objectives. Often the goal of these studies is to determine the most effective strategies to facilitate the emergence of sustainable exploitation of fisheries. Scholars have taken, broadly speaking, two approaches to attain this goal. Some have evaluated the effectiveness of fisheries management tools to reduce fishing pressure while serving the needs of fishers (Béné et al. 2003; Béné & Fried, 2011). Others have focused on the impacts of livelihood diversification, whereby households engage in diverse economic activities, on fisheries and fishing livelihoods (Brugère et al., 2008; Cinner *et al.* 2009; Hill *et al.* 2012).

In recent years, however, there has been a clear recognition among scholars that these two strategies are more effective when combined within an integrated resource management approach (Seivenan *et al.*, 2005; Brugère *et al.*, 2008; Hill *et al.*, 2012; Isaacs, 2011). This premise is based on the notion that together, institutions and livelihood diversification are important component of resilient fishery systems (Matera *et al.*, 2016) and together, they can strengthen the social and economic conditions for sustainable resource exploitation (Seivenan *et al.*, 2005; Burgère *et al.*, 2008).

Nonetheless, very few studies have examined resource management plans that take such an integrated approach and the factors that help create conditions for sustainable fisheries exploitation. For the purpose of this study, we refer to integrated management plans as an approach that combines institutional arrangements and livelihood diversification interventions to reduce fishing pressure and improve fishers' wellbeing.

In this paper I examine the implementation of two integrated management plans in order to extrapolate the institutional and socio-economic factors that help create the conditions for sustainable resource exploitation. More specifically I ask the following two questions: 1. What institutional factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation? 2. What socio-economic factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation? I focus mainly on the factors that positively influence fishers' behaviors. I define institutions as the governance functions relating to "the rules that provide exclusion, create entitlements, regulate uses, and provide for monitoring of the resource and structure participation and decision making" (Isaacs, 2011 p. 364). We focus on the degree of compliance to rules and regulations among fishers as a measure of desirable outcomes. While compliance does not always equate with sustainable exploitation in small-scale fisheries (Hauck, 2008), it is certainly a desirable outcome for resource managers. This is because compliance to rules and regulations increases the likelihood of sustainability; as such conservation scholars have vastly researched conditions that promote and/or deter fishers' compliance to institutions as mechanism to increase the likelihood of sustainability (Ostrom, 1990; Basurto, 2005;

Hauck, 2008). Therefore, we consider compliance to rules and regulations as a form of sustainable resource exploitation.

To reach the study's objective, we compare and contrast two traditional fishing communities located around the transboundary biosphere reserve of the Senegal River Delta (SRD) in Senegal and Mauritania, in West Africa. I chose these two communities because of the distinct integrated management plans affecting them, and which have yielded contrasting forms of fisheries exploitation. In the community in Senegal, fishers have defied the regulations on fishing activities regarding seasonality and access to protected grounds resulting in unsustainable fishing practices. On the other hand, in the community in Mauritania, most fishers respect rules by ceasing commercial fishing during the low season, avoiding fishing in other fisheries and excluding migrant fishers.

Ostrom and Basurto (2008) advocate for further research on why some resource users are able to govern the use of resource over time in a sustainable manner and why others don't or fail to make the effort. In this article, we seek to understand the reasons behind the diverging outcomes in the way each community exploit their resources. We build from the sustainable livelihood framework (Allison & Ellis, 2001) to unveil the institutional arrangements and socio-economic factors that can help explain why the integrated management plan resulted in sustainable resource exploitation in one community but not in the other.

In order to accomplish this objective, I first review the literature on the two overarching premises of institutions and livelihood diversification in relation to fisheries management. I then provide a conceptual framework based on the sustainable livelihood

framework, followed by a presentation of our study area in which I briefly presents some background information on livelihood practices and institutional arrangements. This is followed by the methods and results. Finally, I discuss the findings and provide some policy and research suggestions in our conclusions.

3.3. Literature Review

3.3.1. Institutions of small-scale fisheries

The drivers of fisheries decline are very complex. Factors include market demand, climate change and ecological mutations due the construction of dams (Ogotu-Ohwayo & Balirwa, 2006; Youn *et al.*, 2014; Winemiller *et al.*, 2016). However, this issue has also widely been attributed to unsustainable fisheries exploitation driven by excessive fishing effort, use of destructive fishing gears, capture of immature fish and outdated fisheries laws and regulations, among others (Hara & Raakjaer Nielson, 2003; Jamu *et al.*, 2011; Raby *et al.*, 2011; Youn *et al.*, 2014). As a result, policies have largely focused on developing effective fishery institutional and governance arrangements to control the rate of unsustainable exploitation. For a long time, fisheries institutions were structured around a centralized management system (Ogotu-Ohwayo & Balirwa, 2006). The institutional processes that supported these centralized systems were predominantly based on ecological assumptions of an achievable sustainable yield (Sarch & Allison, 2001). Thus, the management of fisheries is centered principally on resource exploitation regulations (e.g. seasonality, mesh and gear sizes, reduced fishing effort), or restricting fishers' entrance (Kolding & Van Zweiten, 2011).

Such measures are known to promote positive ecological outcomes in resource growth and recruitment, increasing fishery yields (Kolding & Van Zweiten, 2011). However, they are mostly established without the participation of fishers and may overlook important ecological and/or social elements such as the natural regulation of small-scale fisheries, and the rationality of fishers' responses to resource fluctuations (Sarch & Allison, 2001; Kolding & Van Zweiten, 2011). Moreover, it ignores the livelihood security function of fisheries for the poorest and most vulnerable groups in Africa (Smith *et al.* 2005; Overa, 2011). Hauck (2008) maintains that the formulations of fishery institutions must be founded on a better understanding of impacts on social and economic inequities, which former/previously enacted institutional arrangements tend to ignore. As a result, the institutional interventions limiting fisheries exploitation have failed to slow down the rate of resource depletion and have exacerbated conflicts among stakeholders (Sarch, 2001; Hara & Raakjaer Nielson, 2003; Funan, 2006). Furthermore, others have attributed the failure of centralized resource management from the behavior of policy makers and people in power who opt to serve their own interests rather than that of the public (Acheson, 2006; Njaya, Donde & Béné, 2012).

Consequently, a wave of decentralized fisheries management in Africa began in the late 1990s through a co-management system in which some management authority is devolved to an organization at the community level (Zulu, 2012). Ostrom (1990) advanced eight management principles for sustainable governance of common pool resources (CPR), which promotes resource use rights for local communities. Some of those principles have been fundamental in designing co-management fisheries systems

and improving fishers' attitude and behavior towards resource exploitation (Ostrom & Basurto, 2009) and increase the power of local fishing communities (Raemaekers, S., 2011; Zulu, 2012). Advocates of fisheries co-management have often pointed to its important role in conflict resolution through the facilitation of negotiations between different stakeholders and promoting resource stewardship (Berkes, 2009; Khan & Sei, 2015; Raakjaer *et al.* 2004). Although the state retains control over the resources, co-management was also regarded as a vehicle for ensuring property rights for local fishing communities and their participation in the decision-making process (Hara & Raakjaer Nielson, 2003; McClanahan, Muthiga & Abunge, 2016). Nonetheless, Ostrom (2008) cautions that weak institutional arrangements can be a source of resource overexploitation in any form of management system. Acheson (2006) asserts that, in fact, institutional failure is a major reason why co-management systems have also failed in conserving sensitive resources.

In more recent years, scholars have recognized that institutional arrangements alone are not sufficient and that fisheries management plans should have a 'portfolio' of approaches to respond to the diversity of issues (Salas & Gaertner, 2004; Kahn & Sei, 2015). Livelihood diversification is another popular mechanism that has been advanced to sustainably manage fishery resources (Hill, 2005; Brugère *et al.* 2008; Finkbeiner, 2015). As such, scholars have advocated the combination of management institutions and livelihood diversification as an integrative approach to create the conditions for sustainable fisheries exploitation (Brugère *et al.*, 2008; Cinner *et al.* 2009; Hill *et al.* 2012).

3.3.2. Livelihood diversification and fisheries management

Ellis (1998) defines livelihood diversification as the “process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standard of living” (p. 4). Livelihood diversification in fishing communities is a common adaptation strategy to buffer against resource fluctuations, especially in developing countries (Brugère et al., 2008; Cinner et al., 2009; Hill *et al.* 2012; Martin et al., 2013; Olale & Henson, 2012; 2013). Fisheries are high-risk occupations prone to seasonal fluctuations in resource availability. Therefore, fishers tend to diversify their activity portfolios with the goal of securing different sources of income at different point in times in order to reduce the risk of livelihood failure. This livelihood strategy has proven to build resilience for fishers’ households facing fluctuations in resource abundance, seasonal cycle of resource use, and changes in access to resources (Marschke & Berkes, 2006; Matera, 2016).

Geheb & Binns (1997) explain that a combination of fishing and small-scale farming is part of traditional food production systems that have proven to be resilient in many instances. Many households living around African freshwater lakes and wetlands combine fishing with agriculture in order to achieve food security (Geheb & Binns, 1997; Ellis & Allison, 2005).. Further, several studies revealed that agriculture in fishing communities also improves financial security by providing households supplementary income to maintain their wellbeing throughout different seasons (Geheb & Binns, 1997; Béné *et al.* 2009; Olale & Henson, 2013).

Within the context of fishery management, a common perception is that livelihood diversification among fishers is an important characteristic of the sustainable fishery systems (Allison & Ellis, 2000; Marschke & Berkes, 2008; Brugère *et al.*, 2008). Livelihood diversification can reduce pressure on resources in times of scarcity or diminishing economic returns by giving an opportunity for fish stocks to recover (Ju Larsen *et al.*, 2003). Theoretical research suggests that as complementary activities become available, fishers are more willing to stop fishing sooner as catches decline (Cinner *et al.* 2009). Given the potential of this strategy to reduce pressure on fishery resources and improve wellbeing, conservation organizations have tended to promote livelihood diversification as a behavior-changing tool (Hill *et al.*, 2012; Wright *et al.*, 2016). For example, ecotourism projects were introduced in fishing communities around Lake Victoria in Tanzania as a diversification strategy (Hill, 2005; Brugère *et al.*, 2008). In the Philippines, seaweed farming was introduced to fishing households as a mechanism to reduce fishing pressure (Hill *et al.*, 2012). However, researchers found that different social and economic variables strongly influence the results of such diversification interventions (Seivenan *et al.*, 2005; Hill *et al.*, 2012; Wright *et al.*, 2016). Therefore, researchers believe that livelihood diversification must be combined with fishery management institutions in order to better regulate the pattern of fishing activities (Ju Larsen 2005; Brugère *et al.*, 2008; Hill *et al.*, 2012). However, very few studies have looked at integrated management plans that have taken such an approach and the conditions under they would work. In this paper, we focus on institutional and

socio-economic factors that help strengthen the conditions under which integrated management plans can result in sustainable fisheries exploitation.

3.4. Sustainable Livelihood Framework

For the purpose of this study I used the sustainable livelihood framework (SLF) to examine the institutional and diversification processes under two different fisheries management styles, in order to extrapolate the key elements embedded in these processes that help explain the outcomes on fisheries exploitation in each community. This framework supports a more complete understanding of fishers' livelihoods in relation to fisheries management systems. An important feature of the SLF approach is that it provides a tool to analyze the interrelations between sources of income from other parts of the economy and the fisheries sector under different institutional arrangements. Therefore, it advances different notions about the underlying processes of livelihood diversification among fishers and the outcomes of this strategy (Allison & Horemans, 2005).

According to Allison & Ellis (2001), there exist a link between household assets, the activities in which households engage, and the mediating processes (e.g., institutions, regulations) that govern access to those assets and alternative activities. The different patterns of asset holdings (e.g., land, livestock, savings) can make a big difference in how families are able to withstand shocks and which livelihood pathways they decide to adopt to improve their wellbeing (Brugère *et al.* 2008). In the SLF framework, Allison and Ellis (2001) focus on key elements, comprised of institutional processes, assets, and

intra-household responses, that together are a function of the livelihood strategies of fishers' and the social and environmental outcomes of these strategies.

Starting with the institutional processes, household livelihood security of fishers can be sustained through community-level institutions that affect access to resources. For example, flexible rules of entry to fisheries support those in need of fish resources for daily income. These institutions also play an important role in mediating access to resources for livelihood diversification. For example, institutions that promote flexible financial mechanism for alternative occupations recognize the inherent variability of the fisheries (Charles & Herrera, 1992). Further, based on the asset profile of fishers, they adopt different livelihood pathways with varying outcomes. In fact, access to land is essential to facilitate the livelihood diversification process for many households in fishing communities (Ellis & Allison, 2005). Finally, the intra-household responses refer to the roles that family members play in achieving livelihood security. For instance, family labor time can be allocated in different ways in order to adapt to resource scarcity during certain periods. Family members can also engage in diverse activities and pool income from different sources whenever the need to and opportunity arises. Overall all these factors are a function of specific circumstances in different fishing communities and interact in shaping the outcomes of livelihood strategies (Allison & Horemans, 2006). This analysis allowed us to better visualize how institutions and livelihood diversification work in complementarity to facilitate the emergence of sustainable fisheries exploitations.

3.5. Methods

3.5.1. Study area and background

This article focuses on two fishing communities around the transboundary biosphere reserve of the Senegal River Delta located in Senegal and Mauritania. The Black Moors make up the predominant ethnic group in the study area followed by the Wolof. Both communities primarily consist of traditional fishers who complement their fishing income from agriculture and livestock. Table 1 provides a summary of relevant characteristics for each community. The communities that were selected for this study are located outside of the two largest protected areas, namely *Diadieme* outside of Djoudj National Bird Park, in Senegal and *Ziré Taghredient* (*Zire* hereafter) outside of Diawling National Park, in Mauritania. These two parks have implemented integrated management plans that differ in their institutional arrangements and livelihood diversification strategies.

In Mauritania, the park operates using a co-management arrangement between resource managers and local communities that is based on a concession system. In this system, each village has the right to sustainably exploit fishery resources within their clearly defined territorial unit located in the park. Additionally, diversification interventions focused on existing livelihood strategies were implemented as a major component of their integrated management plan.

In Senegal, the local government has full ownership and management rights over the fishery resource of the protected area and the participation of local communities in the management of the park is very limited. Villagers have no fishing rights inside the

protected area and are limited to fish within the buffer zones. Moreover, to reduce fishing pressure, NGOs and park officials have introduced new forms of revenue generating activities as a diversification intervention.

Rules in both parks control commercial fishing activities during the reproductive (low fishing) season, from April to July, and limit the number of fishers in the area (GIRMAC, 2004; DPN, 2010; MEDD, 2013). However these integrated management plans have yielded distinct forms of resource exploitation in each community. In Zire, most commercial fishing activities cease during the low fishing season and fishers dedicate their time to farming. Additionally, only fishers from the village fish in the area. However, this was not the case in Diadieme, where fishers still continue fishing during the low season and migrant fishers are present on their fishing grounds.

The ideal fishing season occurs at the start of the rainy season in August and continues throughout the colder months all the way to February. Local fishers and resource managers reported that, this is a time when catch rates and economic returns from fishing activities are at their highest levels (Magrin & Seck, 2009; UEMOA, 2013; MEDD, 2013). April to July is the reproductive season for most fish species in this area. During this time, mature fish migrate to other areas of the water body in order to reproduce, effectively limiting fishers to the more easily caught, pelagic, juvenile fish (Pandare & Sanogo, 1996). Therefore, fishers tend to catch mostly juvenile fish during this period. As stated by fishers in Diadieme and Zire, during this time catching enough economically valuable fish is difficult. Thus, the months from April to July constitute a very critical time in the fish life cycle; the intensity of fishing activities during this time

has a significant impact on fish productivity and result in further decline in fish stocks (Pandare & Sanogo, 1996).

3.5.2. Data collection and analysis

The data for this study was collected from March-August 2014 and March-June, 2015. 84 semi-structured interviews (see table 1.1) were conducted with the head of fishing households focused on household level aspects (including diversification strategies). Additionally, 11 unstructured interviews were conducted with key informants such as village leaders and governmental field technicians to capture institutional factors. The data was also complemented with informal conversations with community members, participant observation, and secondary data from technical reports and governmental documents. Most interviews with fishers and village leaders were conducted by the PI in Wolof (the main local language), or in Moorish (spoken by the Moors) with the help of a local translator who was recruited from the village (translation happened from Moorish to Wolof). I conducted all interviews with governmental field technicians in French. I am fluent in both Wolof and French and I transcribed each interview into French.

For the semi-structured interviews, purposive sampling was used to target households who had at least one member who cited fishing as a primary livelihood activity and were engaged in farming during the years the data was collected. When the head of household was not present, the spouse was interviewed, which happened in 15 interviews. In order to understand the factors that explain how diversification processes

influence decisions about fishing activities, I gathered information through open-ended questions in the semi-structures interviews. Questions focused on income pooling, labor organization, and community level support in their livelihood strategies. Closed-ended questions were also used to gather information about their assets (e.g. fishing boats, livestock, farm workers), revenues generated from farming, and additional household income sources.

To gain a better understanding of how institutional factors influenced the pattern of fisheries exploitation I conducted 11 unstructured interviews with village leaders (n=6) and local government officials (n=5). These interviews focused on the management of the local fisheries, issues encountered with local fishers, fishing practices and the presence and role of community-based organizations. The qualitative data was analyzed through a directed content-analysis approach (Hsieh and Shannon, 2005), which allowed the analysis and interpretation of data guided by the concepts under study: in this case, fishing practices and related household level and institutional factors. Using this approach, the concepts under study are used to guide the initial coding. However, during the data analysis, the researcher allows underlying themes to emerge from the data for a deeper analysis of these concepts (Hsieh and Shannon, 2005).

As I reviewed each interview, a summary table was created listing the different concepts under study (household and institutions factors). For each concept, I listed the different associated sub-themes that emerged during the interviews. These were reported in the finding sections indicating which were more commonly recounted. The process was repeated in each community. Separating the data by community allowed me to

compare contextual factors that could help explain the results. To ensure trustworthiness of the results, we used reflexivity (Guba & Lincoln, 1989) by contrasting the sub-themes with field notes from participant observation and informal conversations with community members. We also contrasted the data from the interviews with fishers with the information that emerged from our unstructured interviews. There was consistency between these sub-themes and the data collected from participant observations, informal conversations, and across the unstructured and semi-structured interviews.

Table 2. Characteristics and fishing practices of communities

Community characteristics	Zire (Mauritania) Number of Interviews =40	Diadieme (Senegal) Number of Interviews =44
Population	~540	~693
Number of Households	95	110
Main economic activities	<ol style="list-style-type: none"> 4. Fishing 5. Commercial horticulture 6. Livestock 	<ol style="list-style-type: none"> 4. Fishing 5. Rice production 6. Commercial horticulture
Fishing practices	<ul style="list-style-type: none"> • Commercial & subsistence fishing. • Fish only from August – March • Cease commercial fishing from March –July; • Migrant fishers excluded from fishing grounds 	<ul style="list-style-type: none"> • Commercial & subsistence fishing. • Fish all year long regardless of seasons. • Fish in other fisheries; • Community members don't oppose migrant fishers

3.6. Findings

3.6.1 Institutional factors

The findings reveal two important factors that were present in Zire but not in Diadieme: First, participatory institutional arrangements that created a sense of ownership and consensus among fishers and second, institutional support to enhance the local livelihoods of fishers (see Table 1.2).

3.6.1.a. Sense of resource ownership and consensus among fishers

In 1995, the Diawling National Park (DNP) adopted a concession system of its fisheries; as a result, each village has its own concession within well-defined boundaries and fishers' cooperatives were created to enable village support. Today, each concession is jointly managed between the park administrators and the cooperatives, and fishers must become a member of the cooperative in order to fish in the village concession. Membership to the cooperative is determined by the residency status of the fisher. In other words, you have to be a resident of Zire –following traditional arrangements - in order to become a member of the village cooperative.

Members of the cooperative are also in charge of enforcing rules and monitoring fishing activities in the village with the support of park guards. To facilitate this, they have a small surveillance post at the concession-landing site. Moreover, alongside local park officials, members take turns monitoring and reporting daily fishing activities including the number of fishers per day and the average amount of catch. Resource managers, in turn, use this information to closely monitor the rate of exploitation of the

fisheries. Fishers have noted an overall positive relationship with park officials resulting from their collaboration in the monitoring process. A fisher expressed his satisfaction with this relation: “You know, we don’t have any problem with them. When we need something we go to them. Really it’s been good, thank God.”

Table 3. Management and institutional characteristics of protected areas

Community/ Protected Area	Management Style	Role of community- based organization	Management goals	Incentiv e mechani sm
ZIRE: Diawling National Park - Mauritania	<ul style="list-style-type: none"> • Co-management between local government officials* and community-based organization; • Concession style/territorial use rights for village. 	Fisher Cooperative: <ul style="list-style-type: none"> • Advocacy and support for local fishermen; conflict resolution • Involved in design and enforcement of rules and regulation about fishing activities and resource monitoring; • Provide support for economic diversification through farming. 	<ul style="list-style-type: none"> • Fisheries resource conservation; • Sustainable resource use; • Sustainable resource-based livelihoods. 	<ul style="list-style-type: none"> • Benefits of resource conservation • Peer pressure, • Internal punishments with government back up.
DIADIEME: Djoudj National Bird Park – Senegal	<ul style="list-style-type: none"> • Govt. control with limited involvement of community-based organization; • Exclusionary except for buffer zones. 	Local Fisher Council <ul style="list-style-type: none"> • Intermediary between fishers and park officials; and conflict resolution 	<ul style="list-style-type: none"> • Fisheries resource conservation 	<ul style="list-style-type: none"> • Government punishment • Persuasion

*Local government officials are the parks administrators who are in charge of managing the resource.

The park managers explained that fishers in Zire had a high level of organization and understanding among themselves mostly because of the work of the cooperative. In fact, there was a common understanding among fishers who were interviewed that, from March through June, no more than 10 fishers from the village were allowed to fish for commercial reasons and they were only allowed to sell their fish in the village. This suggests that there is a level of consensus and understanding among fishers about how resources should and or should not be used. Additionally, the system of fishing concession with clearly defined boundaries and resource users promoted a sense of ownership among fishers. Reserve managers believed that this sense of ownership fostered a desire to protect the resource. Fishers and reserve managers expressed this sense of ownership by referring to the Tchelitt basin as that of the people of Zire. People beyond Zire were also aware of such entitlement. For example, in Diadieme, fishers knew that the Tchalitt basin was reserved for the people of Zire and that one had to be a member of the cooperative or the permission of the village chief.

Further, according to fishers and park officials, during the low season, many fishers used to travel to other fisheries in search of better catches, however, this trend declined since they started the concession system. As the park director explained:

“Fishermen in Zire know the seasons for fishing and farming. When the fish start to diminish they turn to farming. They don’t go somewhere else to fish. The seasons are very clear for them and it makes our job easier.”

In Diadieme, which is located on the Senegal side of the reserve, the situation was different. There are no designated fishing areas for specific villages as they all have

equal access to the buffer zones and other areas outside of the protected areas. However, fishing within the protected area is strictly prohibited. Park officials noted that enforcing fishing regulations have been very challenging. For example, fishers are often caught fishing within protected area boundaries. During the low fishing season, fishers still continued commercial fishing, using gears that are not in compliance with regulations.

As a park guard strongly pointed:

“These people don’t understand what ‘biological rest’ is. They just fish whenever they want at any place. We keep arresting them. [...] They’re spoiling the river!”

In 2010, with the support of a NGO, a local fishers’ council was set up to serve as a mediator with fishers and park officials to represent the interest of fishers at the regional level. However, the role and level of participation in the management of fisheries of the council is very limited. Fishers in Diadieme felt that the local council had still not made a difference in their capacity to negotiate with park officials’ terms of access to fishing grounds and neither improved the relationship between the two parties. Further, fishers often referred to the reserve in Mauritania as a good model of fisheries management and the positive results it yielded. For example, the vice president of the fisher council explains:

“In Diawling fishers are allowed to fish in the park. Each village has its own space for fishing. [...] But they don’t destroy it. The villagers make sure that no one from outside fishes in there [...] why can’t we have the same? All these people here do is fine us and put our children in jail.”

Overall, the same institutional conditions to regulate fishing activities that were present in Zire were not present in Diadieme and can help explain some variations across communities regarding fisheries exploitation.

3.6.1.b. Institutional support for local livelihoods

As part of the integrated management plan, program managers in Mauritania have mostly focused on building upon the local livelihood strategies. In the DNP management plan, one of the objectives is clearly stated to promote what is referred to as eco-development:

“Eco-development: strengthening traditional activities of local communities that are compatible with the conservation-restauration objectives and develop new activities”(MEDD, 2013 p.40).

As a result, collaboration between cooperatives, reserve managers and NGOs exist in order to provide institutional support for local livelihood diversification strategies. Such interventions have particularly focused on activities that can help supplement household income during the low fishing season, especially commercial horticulture.

For example, funding was provided to both fishermen and women cooperatives to create a credit scheme and provide technical support to its members. Parts of the funds were invested to open a community store in Zire. The profits from the store are used to provide financial support to its members to develop their horticultural project. They also provide seeds, fertilizers, and other tools that are needed for farming operations. Around 35 percent (15 out of 40) of fishers claimed to have used the services of the cooperative.

Additionally, reserve managers monitor economic activities that are emerging and have the potential to generate substantial amount of revenue, particularly during the low fishing season. For example, the harvest and sale of the acacia clove by women is becoming important because of an increased demand for this product. Consequently, in the past two years, reserve managers are trying to partner with NGOs to provide funding and technical support for women in Zire to develop the harvest and sale of the acacia clove.

The situation was much different in Diadieme where no local supporting organization was present. In fact, fishers complained several times that they were on their own and that currently no formal organization supports them, even though there had been several attempts in the past. In 1994, with the support of the International Union for the Conservation of Nature (IUCN), an ecotourism project was set up to channel economic benefits to the community and provide incentives for conservation. The project was supposed to generate substantial employment for fishers. While still on going, this project has not been successful at changing fishers' behaviors. According to fishers, the number of employment that the ecotourism project generated was very limited and reserved for mostly the local elite. Moreover, the ecotourism season happened at the same time as the high fishing season. Therefore fishers couldn't be involved in ecotourism activities, which, according to fishers, generate far less income than fishing. In 2010 the Spanish NGO that helped establish the cooperative in Zire set a small project in their villages to start a micro-credit enterprise. However, partly because

of organizational issues, most households failed to repay the money they borrowed, leading to its failure.

Our findings indicate that the institutional arrangements and livelihood support embedded in the different management style have created different conditions for fisheries exploitation in each community. Yet, we also found that the nature of diversification at the household level and through livelihood-focused interventions also influence conditions for sustainable resource exploitation. Therefore, in the following section we describe the predominant socio-economic factors embedded in the diversification process at the household level and through interventions that influence fisheries exploitation.

3.6.2. Socio-economic factors

Overall, we found three socio-economic factors that contributed to the conditions for sustainable resource exploitation. These factors include, local livelihood strategies that are congruent with household needs, the contribution of women in sustaining household income, and livelihood diversification interventions that are aligned with pre-existing livelihoods.

3.6.2.a. Local livelihoods strategies

Households' access to income sources that are synchronized with household needs in terms of seasonality can help strengthen the link between diversification and sustainable exploitation of fishing resources. In other words, access to a steady income

flow from alternative sources during the low fishing season incentivizes fishers to halt fishing activities when mandated. The income flow of a household depends on the combination of activities in their livelihood portfolio, their livestock holding, and the financial contribution of women.

In Zire, the household livelihood portfolios comprise of fishing as the most important source of income, but are complemented with commercial horticulture and livestock holding (see table3). Commercial fishing is practiced within the village concession on a seasonal basis. The highest capture rates occur between August and November and start to decline from December to March. Commercial fishing is halted for the majority of fishers from April to July due to lower catches and economic return. Households have reported that these months constitute a difficult period in terms of access to food and income. During this time, fishers turn to commercial horticulture, an irrigated form of agriculture, to supplement their income. Horticultural operations are carried from December to August with multiple harvests starting in February. In 2015, households collected an average of 1,514,715 FCFA (~\$2,754) in commercial horticulture revenues. Additionally, households in Zire have an average of 38 goats and 2.6 sheep. According to fishers, this livestock is used as a form of savings and a source of cash during a time when income is needed the most, particularly when fish stocks are low.

The findings in Diadieme revealed that the livelihood portfolio of households provided less frequent income flow than in Zire. Fishing constitutes their main source of income, followed by rice production and CH. Unlike in Zire, commercial fishing

activities is carried all year long regardless of the season. Therefore, fishing and farming are carried out simultaneously. Even though rice production contributes significantly to the household income, the collection of revenue occurs at the time when economic returns from fishing are high. As a result, rice production has little effect on fishing activities. However, for the households who practice CH, they collected ~1.8 times lower revenue than those in Zire and had a much lower diversity of crops (see Table 3). Because they collected lower and less frequent revenue, fishers turned back to fishing to meet their daily cash needs while waiting for farming revenues. One interviewed fisher explained that in Diadieme “If you stop fishing, your family will not eat.”

3.6.2.b. Women contribution to household income

Women in Zire also contributed significantly to the household portfolio by participating in post-harvest fishing activities. They dry and smoke their fish to sell to larger markets. This is a business that generated up to \$20 for each day they were able to sell their product. They also participated in commercial horticulture during the low fishing season. Women collected an average 538,450 FCFA (~\$979) in horticultural revenues per parcel. Therefore, in Zire, women brought a significant amount of income to the household to help compensate for the lost income during the low fishing season, providing further incentive for men to drastically curtail their fishing efforts. As such, women in Zire help sustain household income through different seasons by participating in activities outside of the fishing sector. In fact 40 percent of fishers (16/40) mentioned

that they were able to halt commercial fishing because their wives income helped meet their daily needs.

Table 4. Livelihood activities in each community.

	Zire (Mauritania)	Diadieme (Senegal)
Activity ranking	<ol style="list-style-type: none"> 1. Fishing 2. Commercial horticulture 3. Livestock rearing 	<ol style="list-style-type: none"> 1. Fishing 2. Rain-fed rice production 3. Commercial horticulture
Percent of HH practicing farming (by type)	<ul style="list-style-type: none"> • Commercial Horticulture – 76 percent 	<ul style="list-style-type: none"> • Rice production – 73 percent • Commercial Horticulture – 26 percent
Ave. CH* revenue/HH**	1,377,000 FCFA ¹ (\$2503)	768,000 FCFA (\$1,396)
Livestock holding / HH	38 goats 2.6 sheep	4 goats 1 sheep
Women economic activities	<ol style="list-style-type: none"> 1. Fish processing and trade 2. Commercial horticulture 3. Petty trade 	<ol style="list-style-type: none"> 1. Petty trade 2. Commercial horticulture

• *Commercial Horticulture; ** Household*

In Diadieme women’s economic contribution to the household was less important. Many women did not engage in any economic activity and those who did, were involved in petty trade. Most women who were actively engaged in commercial horticulture were

¹ At the time of the study \$1 = approximately 550 FCFA (West African Franc)

² People refer to “onion” farming as commercial horticulture in general

³ At the time of the study \$1 = approximately 550FCFA (West African Franc)

widows or divorced and had to fulfill the role of the head of household. A fisher in Diadieme remarked, “I am the only one here who brings in money. They all depend on me. I can’t stop working.” Overall, in Diadieme the economic contribution of women is not sufficient to help compensate for the lost income during low fishing season, therefore they did not provide sufficient incentive for men to curtail their fishing efforts during that period.

3.6.3. Livelihood diversification interventions

Diversification interventions that are congruent and aligned well with local livelihoods are more effective at positively shaping fisher’s behavior. Instead of introducing new alternative activities such as ecotourism, projects in Mauritania have focused on identifying and strengthening local livelihood strategies that have the greatest potential to lead to conservation outcomes and improve wellbeing. Thus, there is an emphasis placed on relieving pressure on sensitive fishery resources by promoting economic activities that are carried out during the low fishing season. Furthermore, because of the support provided to pre- existing livelihoods, community members were more accepting of these projects. For instance a fisher in Zire indicated:

“I am a fisherman just like my ancestors were. But I am also a great farmer. I grow all kinds of crops like turnips, okra, onions...all kinds [...] You can never take that away from me.”

The comment above suggest that focusing on pre-existing livelihood strategies is an approach that made more sense in the eyes of the local people, because these projects aligned well with their way of life.

In contrast, in Senegal a new form of livelihood, specifically ecotourism, was promoted as a diversification strategy. Fishers in Diadieme expressed very little interest in the ecotourism project. Furthermore they felt like it benefited mostly the local elite who were not fishers for the most part. Additionally, when asked which activity they felt would most likely improve the livelihoods and reduce their fishing activities, the majority explained that commercial horticulture would have been a more viable project. This point was brought up during several informal conversations. One of them noted:

“Ecotourism gave us nothing. I am not going to waste my time. Let me continue fishing, at least I know I can feed my family with that [...] If they really wanted to help us, they would help us with our gardens.”

This quote is reflective of the overall perception of people in Diadieme about ecotourism activities, which they believe have not improved their wellbeing and are incongruent with their own preferred livelihood strategies.

3.7. Discussions

The study was carried out in order to examine the institutional and socio-economic conditions for sustainable resource exploitation when fisheries institutions and livelihood diversification are combined under one integrated management plan. The case studies from Mauritania and Senegal present two distinct integrated approaches with different outcomes. The findings reveal that the integrated management plan implemented in Mauritania has been more effective at creating the right conditions to

facilitate sustainable exploitation of fishery exploitation. The factors that contributed to such outcome of the integrated management plan include:

- Factors created through management institutions: sense of resource ownership, consensus among fishers and provide support for local livelihoods.
- Factors created through livelihood diversification: Local livelihood strategies that are congruent with household needs, contribution of women and livestock in sustaining household income and, diversification interventions that are well integrated with already existing livelihoods.

3.7.1. Fisheries institutions

The findings in Zire support some of Ostrom (1990) principles for the sustainable management of common property resources. The principles that can be applied in this study include community territorial usage rights with clearly defined boundaries and collective choice arrangements that allow most resource appropriators to participate in the decision-making process concerning rules and regulations and the enforcement of such rules. Overall, we found that the management institutions promoted a sense of resource ownership among fishers in Zire and a desire to protect what belongs to them. Furthermore, because the participation of cooperative members in the design and enforcement of rules, there was a consensus among fishers about how resources should and should not be exploited. McCay et al. (2014) found similar results in Mexico, where the concession system in which fishers' cooperatives were very involved

in the management of the local fisheries was effective at influencing fishers' behaviors. Among the factors that contributed to such outcomes is the sense of 'vigilance' that resulted from their participation in the decision-making process and enforcement of rules.

Although these results provide argument in support of co-management systems, it is also important to note that such institutions don't guarantee positive results (Acheson, 2006; Ayers & Kittinger, 2014; Lewins *et al.*, 2014). In Africa particularly, the failures of fisheries co-management have been attributed to the limitations in the downward transfer of power and responsibility and the undermining of existing traditional institutions (Lewins *et al.*, 2014). In Mauritania, however, two factors may have helped in countering such constraints. First, the cooperative participates in the design of rules and monitoring of resources; as such, even if the cooperative does not have full power over the Tchallitt Basin resources, it still has substantial responsibility in managing it. Second, the director of the cooperative is the village chief. Therefore, there is a respect of traditional institutions in this regard.

In the case of Senegal, the conflicts that ensued as a result of the exclusionary management system have engendered a lack of trust between the fishers and the reserve officials. Matera (2016) found that the level of trust in local government is a variable that influences fishers' acceptance of conservation policies. The lack of trust towards reserve managers helps explain why the institutional arrangements have failed to create the conditions for sustainable resource exploitation in Senegal. Furthermore, exclusionary institutional arrangements fail to recognize the considerable contribution of

fisheries to local livelihoods and food security (Hara and Neilson, 2002). Restricting access to such important resources not only undermines the conservation outcome that it seeks in the first place, but also diminishes the livelihood security of fishers. Therefore, exclusionary institutions can deteriorate the conditions for sustainable outcomes.

While scholars recognize that co-management systems are more likely to create conditions for sustainable fisheries exploitation than centralized and exclusionary regimes, this study shows that implementing an effective livelihood diversification strategy can also strengthen this relation. This entails providing institutional support for local diversification practices. For instance, in Mauritania, the fishers' cooperative did not just provide support to its members for fishing activities, but also facilitated their economic diversification through the provision of technical and financial support for commercial horticulture and other non-fishing based activities for women. Providing the seeds and other important inputs to fishers was critical in their capacity to diversify their crops in order to secure regular income flow. Charles & Herrera (1997) also found that in Costa Rica, in communities where fishing cooperatives also provided support for livelihood diversification to its members, there was a greater level of sustainable resource exploitation. Therefore, institutional arrangements for fisheries management should also incorporate the distribution of benefits to its members beyond fishing related activities. More specifically they must adopt an integrated livelihood system approach for fishers and the resources on which they depend.

3.7.2. Local diversification strategies

While diversification is often viewed as a mechanism for sustainable fishing livelihoods, not all diversification strategies create socio-economic conditions for sustainable resource exploitation (Béné et al. 2007). In our study, we found factors embedded in the local diversification strategies that explain the variations in outcomes on fishers' livelihoods and how they exploit resources.

First, in Diadieme, the local diversification strategies did not allow for an income flow that was synchronized with household needs. This is because the majority of households complemented their income with rain-fed rice production, which occurred during the high fishing season. For the few households who were engaged in commercial horticulture, this activity did not provide for daily household needs as effectively as fishing. Results from other studies also show that the capacity of fishing activities to generate almost instantaneous income provided an incentive to fishers to continue fishing despite lower catch and lower economic returns (Béné et al., 2009; Hill et al., 2012). However, our result in Zire shows that for fishing-farming communities, first, the timing of revenues from commercial horticulture (as opposed to rain-fed agriculture) was more synchronized with household needs. They were also able to secure higher and more frequent income flow by diversifying their horticultural crops. Hill et al. (2012) also noted that, in fishing communities in the Philippines, the timing and frequency of income from seaweed farming as a complementary activity accounted for the variations in fishers' numbers when fish stock declined in various communities.

The findings also revealed a very important fact about women's contribution to the household and fisheries exploitation. We found that a substantial economic contribution help sustain household income, which in turn can provide incentive for fishers to cease commercial fishing when resources become scarce. This was the case in Zire, where women were involved not only in fish processing and trading, but also in commercial horticulture and petty trade. As a result, they contributed significantly to a steady income flow through their involvement in both post-harvest and non-fishing activities. It is important to highlight the involvement of women in non-fishing activities that are unaffected by seasonality because this element is essential in sustaining income flow at the household level. Gnimadi et al. (2006 quoted in Brugère et al., 2008) and Massamba et al. (2005 quoted in Burgère et al., 2008) also found that in Benin and Congo, fishers' activities stopped due to low catches when women continued contributing to households. In these case studies women were also involved in non-fishing activities such as the commercialization of wild fruits. Thus, our results provide supplementary evidence of the range of income streams available to fishing households especially from women. Therefore, diversification policies should not be solely focused on providing fishers with alternative occupations, but should also encompass broader goals related to increasing the level and flow of women's income.

3.7.3. Diversification interventions

Traditionally, livelihood diversification is a strategy that has evolved from responses to local environment and broader social context (Sarch & Allison, 2000).

Today, however, diversification interventions tend to focus on introducing alternative forms of livelihoods instead of building on local livelihood strategies (Brugère *et al.*, 2008; Wright *et al.*, 2016). Our results demonstrate that integrated management plans that involve diversification interventions focusing on local livelihood strategies can be more effective at creating the socio-economic conditions for sustainable resource. Wright *et al.* (2016) make similar arguments in support of enhancing rather than replacing pre-existing livelihoods. They maintain that instead of using alternative livelihood programs as a behavior changing tool, it may be more appropriate to focus on existing livelihood strategies with a clear link to conservation as a means to establish good community relations and sustainable resource exploitation (Wright *et al.*, 2016).

The case studies presented in this study provide evidence in support of the previous contention. In Mauritania, the diversification interventions were designed to strengthen traditional activities such as commercial horticulture and emerging activities that were carried during a time when fish stocks are low. We found that this strategy created the socio-economic conditions that enabled fishers to cease commercial fishing when resources become scarce. This was not the case in Senegal, where ecotourism was implemented as a diversification strategy, but had little-to-no effect on fishers' behaviors. Moreover, there was a greater cooperation between reserve managers and fishers in Mauritania. Experiences from Uganda also indicate that interventions focused on local livelihoods has helped improved local attitudes towards conservation, thus reducing conflict and increase cooperation between resource users and protected area authorities (Blomley *et al.*, 2010).

3.8. Conclusions

The fisheries literature is replete with research focused on the effectiveness of strategies aimed at promoting the sustainable exploitation of resources and enhancing the well being of fishers. Researchers such as Funan (2006) and Isaacs (2011) and have evaluated the impacts of fisheries management institutions on livelihoods and resource conservations. Hill et al. (2012) and Olale & Henson (2013), focused on livelihood diversification in fishing communities and its social and environmental outcomes.

The objective of this paper was to evaluate integrated management plans that combine both management institutions and livelihood diversification the emergence of sustainable exploitation of fishery resources. We used the case studies of two communities, one in Mauritania and the other in Senegal, with the intention of exploring institutional and socio-economic factors that help strengthen the conditions for sustainable resource exploitation. Overall, the institutional arrangements must promote a sense of ownership of resources among fishers to increase their willingness to protect their resource as well as consensus about exploitation. Moreover, institutional support must also be provided to facilitate an effective diversification process among fishers.

We suggest that in order to create the right socio-economic conditions, future integrated fisheries management plans also focus on: promotion of diversification strategies that are congruent with household needs and that integrate easily within locally preferred livelihoods and increasing the level and flow of women's income. Focusing on these strategies can address some of the issues that often weaken linkages between livelihood diversification and the sustainable exploitation of fisheries.

CHAPTER IV
LIVELIHOOD SECURITY OF FARMING-FISHERS:
THE EFFECTS OF LIVELIHOOD DIVERSIFICATION FROM
A MULTIDIMENSIONAL PERSPECTIVE

4.1. Overview

Scholars have maintained that livelihood diversification reduces poverty and makes households more resilient to resource fluctuations. However, small-scale inland fishers continue to be among the poorest and most vulnerable social groups in Africa. Past research on the social outcomes of diversification among fishers have focused on its effects on poverty alleviation assuming that higher income levels will lead to lower vulnerability. However, higher incomes do not always translate to resilient fishing livelihoods. A different approach is needed to better understand why diversification leads to resilient livelihoods in some fishing communities but not in others.

In this paper, we use a livelihood security framework in order to capture the various socio-economic effects of diversification and underlying factors shaping its outcomes. Using the case studies of three communities within the Senegal River Delta, we applied the framework to examine how farming, as a complementary seasonal activity, contributes to fishers' livelihoods.

Overall we found that, depending on the form of agriculture that was practiced, farming contributed to fishers' livelihood security in different ways. Commercial

horticulture (irrigated), rather than rain-fed agriculture, was more effective at reducing household seasonal vulnerability to food and income insecurity, in addition to improving nutritional security at the community-level. Furthermore, households that collected high farm revenues were able to build their productive assets by purchasing fishing gears and livestock. Underlying factors shaping these outcomes included risk, crop diversity, household debt accrued, livestock holdings, and technical knowledge. These factors affected the capacity of fishers to achieve livelihood security through farming.

4.2. Introduction

Rural development scholars and practitioners regard diversification, whereby households engage in diverse livelihood activities, as a mechanism to build resilient fishing systems. The underlying logic of this premise is that engaging in complementary activities will provide fishers the resources they need to reduce their vulnerability to diminishing fishery resources (Marschke & Berkes, 2006; Sarch & Allison, 2001). Engaging in complementary activities, in turn, will reduce pressure on fishing resources, as fishing households would cut down their fishing activities while buying food and other necessities through alternative income sources (Ju-Larsen, 2006; Brugère et al., 2008).

Even though livelihood diversification is very common among fishers, empirical evidence shows that inland fishing communities in developing countries continue to grapple with high levels of poverty and vulnerability (FAO, 2014; Béné, 2009; Olale & Henson, 2012). According to the Food and Agricultural Organization fishing-dependent

communities are among the most vulnerable and marginalized social groups in Africa (FAO, 2014). Such scenario raises the following critical question: What factors help explain the outcomes of diversification on fishing-based livelihoods?

Studies on the effects of diversification on fishers' livelihoods have tended to look at how engaging in complementary activities affects their level of poverty with a focus on income (Martin, 2013; Olale & Henson, 2012). However, as Béné (2009) noted, fishers may have higher income levels but remain highly vulnerable to resource fluctuations. That is, higher incomes do not always translate into resilient fishing livelihoods. Thus, a different approach needs to be carried out in order to better capture the multiple underlying factors shaping the outcomes of livelihood diversification.

We believe that an approach framed around the concept of livelihood security will help us better understand the effects of diversification on fishing livelihoods. Central to this concept is the capacity of households to access the resources they need to maintain their wellbeing through present and future environmental and social changes. Importantly, the concept of livelihood security does not only entail income security. It encompasses food security and assets holdings, which are all necessary to reduce household vulnerability to fishery resource fluctuations.

The chosen framework encompasses different dimensions of livelihood security including income, food and nutritional security, and assets. I apply the framework to three small-scale fishing communities of the Senegal River Delta where fishers engage in agriculture as a livelihood diversification strategy. Farming is the most common complementary activity of small-scale fishers in Sub-Saharan Africa (Allison et al.,

2010; Morand et al., 2005), thus understanding the effects of farming on fishers' livelihoods is crucial to developing strategies for poverty and vulnerability reduction focusing on pre-existing strategies. Moreover, unveiling the underlying factors that shape the livelihood outcomes of diversification provides insight into how to turn this mechanism from a coping to an adaptive strategy.

In order to accomplish the study objective, I first present the literature review on poverty, vulnerability, and diversification in the context of farming in inland fisheries. I then offer a framework of analysis based on the dimensions of livelihood security. I follow with our methods, results and discussions sections.

4.3. Literature Review

4.3.1. Inland fisheries, poverty and vulnerability

The concept of poverty was central to earlier research on fisheries livelihoods. The general perception conveyed by such literature was that fishers are among the poorest social groups in rural Africa (Béné, 2003; Panayotou, 1982; Pittaluga et al., 2003). Several reasons are offered to support this assertion. First, there is an intrinsic connection between fishers and poverty (Panayotou, 1982). As an open-access resource, fisheries attract a large number of people who have limited access to productive resources and economic opportunities (Béné et al., 2003). Therefore, inland fishing is typically a source of livelihood for the most destitute groups. Additionally, the accelerated decline in fishery resources coupled with seasonal fluctuations, place fishers at a high risk of continual poverty (Marschke & Berkes, 2006; Youn et al., 2014).

Studies, however, have questioned these conventional ideas noting that the relationship between fishing and poverty is more complex (Allison & Ellis, 2001; Allison et al. 2010; Béné, 2009).

Past research revealed that fishing is not an activity for poor households only. Fishing has different functions for various groups with varying levels of wealth. Additionally, it is part of a complex livelihood matrix that is tightly linked to other livelihood activities, particularly farming (Allison et al., 2010; Béné & Russell, 2007; Pittaluga et al., 2007; Martin 2013). For example, in the Congo River Basin and in part of the Senegal River Delta, studies show that full-time fishers were part of the wealthier groups (Béné et al., 2009; Magrin & Seck, 2009). Therefore, the link between fishing and poverty is not as straightforward and is rather complicated by the inherently complex nature of poverty. For example, income from fishing is often higher than earnings from agriculture or other sources of employment, but vulnerability of fishers may be higher (Allison et al., 2010). Furthermore, full-time fishers may not be the poorest in monetary terms but resource fluctuations in fisheries cause uneven income variability, which causes financial insecurity (Allison, 2004). As a result, the literature has started focusing on vulnerability rather than poverty, as this provides a more complete picture of fishers' livelihoods (Béné, 2009; Chiwaula et al., 2009; Mills et al., 2009).

Research shows that vulnerability of fishing communities is not necessarily tied to what happens in fisheries itself but rather on the broader socio-economic context. For instance, although fish resource depletion and fluctuations are perceived as affecting

fishers' livelihoods, sources of vulnerability related to access to basic needs (e.g., food, health care, and credit) are more fundamental (Mills et al., 2009). Chiwaula et al. (2010) found that in fishing communities in Nigeria and Cameroon, vulnerability was related to the lack of productive assets for fishing and non-fishing activities (e.g. fishing equipment, livestock, land). In order to reduce vulnerability, many fishing households diversify their livelihood as a coping and adaptation mechanism (Goulden et al., 2013). The uptake of agricultural activities is the most common diversification strategy among fishers (Morand et al., 2005).

4.3.2. The role of farming in fishing livelihoods

Fishing-dependent households are prone to resource fluctuations and other socio-economic shocks and stresses, therefore they adopt strategies to best adapt and cope to these variations. Complementing fishing activities with farming remains the most common strategy, particularly in West Africa (Morand et al., 2005). This is because fishers perceive it to be a safer livelihood strategy than being a full-time fisher (Sarch & Allison, 2001). Morand et al. (2005; p. 76) contend “the farmer fisherman produces his own domestic needs in cereals and can thus feed his family without depending on the market. By contrast, the migrant professional fisherman is exposed to a larger number of risks of all kinds.” Geheb & Binns (1997) provide the most detailed account on the relationship between fishing and farming. They maintain that a combination of fishing and small-scale farming is part of traditional food production systems that have proven to be resilient in many instances. This resilience is based on local coping mechanisms

involving the production of varied sources of food in different points in time. As such, for many households who live by inland lake systems, fishing and farming has become inextricably linked to achieve household food security (Geheb & Binns, 1997).

The advantages of farming in inland fisheries goes beyond its contribution to food security as it also provides an extra source of income for households whose livelihoods depend on fishing. For example, Béné et al. (2009) found that fishers who also engaged in farming earn a higher cash-income than fishers who depended exclusively on fishing. Olale and Henson (2013) provide evidence of this argument from their studies on income diversification among small-scale fishers in Lake Victoria, Kenya, where many households engage in farming related activities to complement their income. Therefore, agriculture in fishing communities improves both food and income security by providing households food supply and supplementary income to maintain their well-being throughout different seasons.

However, other studies demonstrate that this form of diversification does not always translate into resilient livelihoods. Martin et al. (2013) claim that there are trade-offs between fishing and farming in terms of time and investment that poses some risk for those who apply this livelihood strategy. Additionally, the risks and constraints associated with agriculture can preclude the livelihood security of fisher-farmers (Kangawale et al., 2008). For example, Béné and Russell (2007) report that the variability in crop production is a major source of vulnerability for fishing communities in the Volta Basin in Ghana and Burkina Faso. In our study, we apply the concept of livelihood security to better understand how farming affects fishers, focused on factors

that help explain why diversification may not translate into resilient fishing livelihoods in SRD.

4.4. Theoretical Framework: Livelihood Security

An effective way to determine the effects of diversification on the wellbeing of fishing households is to assess how it influences each dimension of livelihood security. This is because the concept is centered on the notion that when livelihoods are secure, households are less vulnerable to environmental and social changes. According to Chambers (1989):

“Livelihoods are secure when households have secure ownership of, or access to resources and income earning activities, including reserves and assets, to offset risks, ease shocks and meet contingencies.”

Based on this definition, the most common livelihood security dimensions are, *income, assets and food and nutritional security* (Bhandari & Grant, 2007; Lindenberg, 2002). That means that limited access to one or more of these dimensions, places households in a situation of insecurity. For instance, an inherent challenge of rural households is the mismatch between household consumption needs and the uneven *income* flow caused by seasonality. Pooling income from different sources helps mitigate this mismatch (Ellis, 1998). Therefore, income opportunities must alternate with the seasons associated with the primary activity in ways (i.e. fishing in the case of our study) that support consumption smoothing. Additionally, having a steady and frequent income flow reduces or eliminates the mismatch between needs and cash on hand. Thus,

level, frequency, and timing of income are all important aspect of a diversified income portfolio.

Income obtained from diversification is used to improve the access to and/or quality of *assets* needed to maintain or enhance their wellbeing (Ellis, 2000). Such assets can fit under the 5 forms of capital including, natural, economic, human, social and physical. For example, the revenue obtained from secondary activities could potentially be used to send children to school. In this way, the human capital of the household is improved (Scoones, 1998). Ellis & Mdoe (2003) note the critical role that access to land and livestock play for livelihood security. They explain that both livestock and land can be put to productive use as the building blocks by which the poor can construct their own routes out of poverty (Ellis & Mdoe, 2003). Consequently, diversification can help household accumulate productive assets and invest into different economic sectors (Ellis & Freeman, 2004; Loison, 2015), thereby securing a better living standard by reducing risk, vulnerability, and poverty (Yaro, 2006).

Food and nutritional security is a critical component of overall household wellbeing (Frankenberg, 1996) that some scholars link to vulnerability (Ellis, 1998; Maxwell & Smith, 1992). Food security entails having access to sufficient and diverse sources of food. Given the cyclical food shortages common in rural communities of the developing world (Davies, 1996), it is important that households have an adequate stock of food to last them throughout different seasons. Further, beyond access to food, the level of nutrition each household member has access to is also part of food security

(Frankenberg & McCaston, 1998). Thus, it is also important to question the quality of the food households are accessing when discussing livelihood security.

Table 5 summarizes key aspects and description of each dimension of livelihood security. Therefore, I ask whether and how these conditions apply to farming as a livelihood diversification strategy in the three communities under study.

Table 5. Summary of livelihood security dimensions.

Livelihood security dimensions	Key aspects	Description
Income	<ul style="list-style-type: none"> • Level • Frequency • Timing 	<ul style="list-style-type: none"> • The level, frequency and timing of income from diverse activities help mitigate the mismatch between consumption needs and income levels caused by seasonality.
Assets	<ul style="list-style-type: none"> • Primary livelihood assets • Land • Livestock • Human capital 	<ul style="list-style-type: none"> • The cash resources from alternative occupations are reinvested into assets that can be transformed into cash either through production or sales. • The alternative occupation improves the human capital either through skills acquisition or direct investment into education.
Food & nutritional security	<ul style="list-style-type: none"> • Steady food supply • Access to nutritious food 	<ul style="list-style-type: none"> • The alternative occupation enhances access to sufficient food throughout the various seasons and access to nutritious food either at the household or community level.

4.5. Methods

This study was carried in three communities within the transboundary biosphere reserve of the Senegal River Delta (SDR) located in Senegal and Mauritania. Two of the

selected communities are located in Senegal, *Diadieme* and *Bountou Batt*, and one in Mauritania, *Zire Taghredient*. The black Moors make up the predominant ethnic group in all three villages, followed by the Wolof who settled in the region more recently. These two ethnic groups control fishing and agricultural activities in the region (Fall et al., 2003). All three localities primarily consist of traditional fishers who complement their fishing income from agriculture and livestock. Table 2 provides a summary of relevant characteristics of each community.

The data for this study was collected from March-August 2014 and March-June, 2015. The data collection methods were both qualitative and quantitative conducted in 104 households (via head of the household). When the head of household was not present, the spouse was interviewed, which happened in 17 occasions.

Table 6. Characteristics of study communities

Characteristics N= 104	Zire (Mauritania) n =40	Diadieme (Senegal) n=44	Bountou Batt (Senegal) n=20
Population	~540	~693	~300
Number of Households	95	110	47
Ranking of economic activities	1. Fishing 2. Commercial horticulture 3. Livestock	1. Fishing 2. Rain-fed rice production 3. Commercial horticulture	1. Fishing 2. Commercial horticulture 3. Rain-fed rice production

Source: MEDD (2013), DPN (2010; 2015)

Purposive sampling was used to target households that cited fishing and farming, respectively, as their first and second most important source of income. During the interviews, the first step was to gather baseline information on household member's main economic activities, revenue from farming activities, material wealth (e.g. fishing gears, livestock) and household expenditures (e.g. how they spend their fishing and farming income). This information was collected using close-ended questions from which we derived most of our quantitative data. Semi-structured interviews followed and included questions about their perceptions on their livelihood security, how they experience vulnerability to changes in resource, coping mechanism and risks associated with their main economic activities.

The data was complemented with informal conversations with community members, participant observation, and secondary data from technical reports and governmental documents. Most interviews with fishers were conducted by the PI in Wolof (the main local language), or in Moorish (spoken by the Moors) with the help of a local translator who was recruited from the village. The translation happened from Moorish to Wolof. All interviews with governmental field technicians were conducted as well by the PI in French. The P.I is fluent in Wolof and French.

The qualitative data was analyzed through a directed content-analysis approach (Hsieh and Shannon, 2005), which allowed the analysis and interpretation of data guided by the concepts under study: in this case, the different dimensions of livelihood security. Using this approach, the concepts under study are used to guide the initial coding. However, during the data analysis, the researcher allows underlying themes to

emerge from the data for a deeper analysis of these concepts (Hsieh and Shannon, 2005). The quantitative data was analyzed using basic statistical tools on Microsoft excel. Most of this data was descriptive and used to calculate average farming revenue per household, frequencies and percentages.

Each interview was translated from Wolof to English and transcribed by the P.I. As the researcher reviewed each interview, a summary table was created listing the different concepts under study (livelihood security dimensions). For each concept, the different associated sub-themes that emerged during the interview were listed. These were reported in the finding sections indicating which were more commonly reported. The process was repeated for each community. Separating the data from each community allowed a comparison to be carried in order to reveal the contextual factors that could help explain the results. To ensure trustworthiness were achieved we used reflexivity (Guba & Lincoln, 1989). Reflexivity was achieved by contrasting the sub-themes with field notes from participant observation and informal conversations with community members. I also contrasted the data from the interviews with fishers with the information that emerged through our unstructured interviews. There was consistency between these sub-themes and the data collected from participant observations and informal conversations and across the unstructured and semi-structured interviews. Additionally, secondary data was used to help corroborate some of these findings and gain contextual understanding of the communities. These included technical reports, past studies carried in the region and studies on inland fisheries in West Africa.

4.6. Findings

This study seeks to understand how farming contributes to the livelihood security of fishing households focusing on the different dimensions. The results intend to answer the question: What factors help explain why diversification enhances the livelihood security for some fishing households but not for others?

4.6.1. Seasonality and vulnerability

We first sought to gather households' experiences with seasonal resource fluctuations in order to better understand how farming help them cope with such situations and their responses may affect outcomes of diversification. Figure 3 depicts the seasonal calendar of livelihood activities.

Figure 3. Seasonal calendar of livelihood activities

Activities	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Fishing	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red
Commercial Horticulture				Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green
Rain fed rice production	Yellow	Yellow	Yellow	Green	Green							

Legend:

Fishing: Highest catch rate Declining catch Resource scarcity (reproductive season)
 Commercial Horticulture: Cultivation Harvest
 Rain-fed rice production: Cultivation Harvest

According to interviewees the most difficult period in terms of income and food security occur during the low fishing season, from March to July. During this critical

period, fish stocks are low and the millet and rice crops, which have been harvested four to six months earlier, are exhausted or sold out. The lower catch rates and economic returns on fishing often translate to a low flow of income for the households. In order to cope with this shortage of income, many reported to borrow money from richer households or fish traders to maintain their minimum consumption needs. As a result, the poorest households tend to fall into a debt trap, which, as many of them explained, preclude their financial security. This is because when farming revenues are collected most of it is used to repay the debt they accrued during the previous months.

This was particularly the case in Diadieme and Bountou Batt where more households reported high levels of debt to meet seasonal consumption needs. For example, the wife of a fisher in Diadieme commented:

“My husband doesn't work when the lake is not good [...] so we don't have any money to help us through those months. Sometimes the money from the onions² is not enough. When it comes, you pay back your debt and the rest is not enough to solve your problems”

According to households interviewed, food shortage is also a major issue during the low fishing season. Because their food supply has been exhausted, many households reported to reduce food intake or sending the younger family members to relatives who are better off. A fisher explained that he asks his wife and children to “tighten their stomach until God takes us out of this situation”. The decline in income stream during that time compounds the issue of food insecurity, and many households have to borrow

² People refer to “onion” farming as commercial horticulture in general

food items that are repaid with interests after their first large harvest. Overall, like in many rural households in Africa, resource fluctuations in fisheries and the farming sectors create a situation of high vulnerability to food and income insecurity for the households that were interviewed.

All households that were interviewed engage in farming to complement their fishing livelihood in order to reduce their vulnerability and adapt to seasonal stresses. Nonetheless, it is important to note that the outcomes of diversification on their capacity to mitigate this vulnerability vary in each community. Indeed, a significantly higher number of households reported issues of debt and food insecurity in Diadieme and Bountou Batt than in Zire. While some households in Zire discussed the hardship of living through this period, debt and food shortage was less of an issue in this community. A further analysis of the data reveal some differences embedded in the diversification process for households in each community that help explain this variation in outcomes.

4.6.2. Contribution of farming to income security

Our findings indicate that not all forms of farming lead to income security particularly because of the timing and the frequency at which the revenues were collected. The timing and frequency of income depended on the crops that were cultivated and the types of assets that the households possessed. Rain-fed rice production and commercial horticulture (CH hereafter) are the two main forms of agriculture in the study communities. While rice production yields substantive revenue for many fishing households, the timing and frequency of this revenue is not synchronized with their own

needs. This is because the revenue from rice production is collected during a time when economic returns from fishing are still high. Furthermore, the revenues from rice are collected only once a year thus did not provide a frequent source of income for fishers. Therefore, relying on rice production alone to complement fishing income doesn't provide income security for fishing households.

On the other hand, CH provides income for households at a time when economic returns from fishing are at its lowest. As a result, the timing of income from CH corresponds with low fishing season thereby responding better to the needs of the household. As a fisher's wife in Zire notes, "God made that our turnips and onions are ready when there are no more fish in the lake." Furthermore, household could increase the frequency of income from CH by mixing their crops with short (e.g. turnips, carrots, and cabbage) and long (e.g. onion) production cycles, allowing them to collect small revenues while waiting for the bigger harvest. Overall, we found that higher crop diversity especially in terms of length of production cycles, contributes to income security during the low fishing season.

Households in Zire were the most successful at achieving income security through fishing and farming, where the only form of agriculture is CH. Around 68 percent of households in Zire mix crops that had short and long production cycles and collected the highest revenue in CH (see Table 2.3). As a result, most fishers in Zire didn't have to wait long periods of time to collect their farming revenue at the same time that they also collected a substantial amount in the end. This vastly compensated for the

forgone revenue from fishing. Ultimately, farmers in Zire collected larger farming revenue that was spread more frequently within the household finances.

In Diadieme and Bountou Batt, households are engaged in CH and rice production, however, the frequency and timing of income collected from these activities didn't match their consumption needs throughout the year. Both of these communities collected lower revenues than Zire. The majority of fishers who were interviewed complained about the delayed return from farming activities. Only 13 percent (6 out of 44) of households in Diadieme diversified their horticultural crops, and the majority (87%) cultivated only onions, which had a longer production period. As a result, most households have one major CH harvest in June, leaving them with no income in the previous months (March-May) to help them through the beginning of the low fishing season. Therefore, they collected lower and less frequent revenue from CH. The households in Bountou Batt reported the lowest CH revenue of all three communities. While their crops present high levels of diversification, these present shorter production cycle ones, which allowed them to collect frequent (yet lower) income from CH activities. This is because they did not cultivate crops that yield high revenues such as onions.

4.6.3. Contribution of farming to asset building

We found that investment into household assets using farming revenues were different in all three communities. This variation is mostly due to the amount of farming revenue collected and the amount of debt they accrued. Households were asked to list in

order of importance what they purchased with the revenues they collected from farming (see Table 7). In Zire, which had the highest level of farming revenues, most households reported that they used the money to first buy food supply, and then invested into building and fishing materials, followed by the purchase of goats and sheep depending on the amount of income they had left. In Diadieme, after buying all of their food supplies, they used the rest to pay back their debt they accrued for food purchase and fishing materials. In Bountou Batt, where CH revenues were the lowest, almost all households used it to pay back the debt accrued from the purchase of fishing material and when this was taken care of, they would invest into the production of rice.

Overall households that collected high farming revenues and didn't accrue substantial debt had the capacity to reinvest in the household assets that are important to maintain or improve wellbeing. However, households that were limited by debt were not able to reinvest into other resources, in which case engaging in farming did not help improve their asset base. However no household reported their revenues to be reinvested into the education of children or other family members, therefore there is no improvement in the household human capital, which is important for the livelihood security of future generations.

4.6.4. Contribution of farming to food and nutritional security

4.6.4.a. Access to sufficient food

Overall, our findings reveal that rice and CH improved the food and nutritional security of fishers in all three communities. First in Diadieme and Bountou Batt, where most households practice rice production, interviewees explained that they keep a few

Table 7. Farming revenue, crop diversity and household expenditures per community

CH Revenues, Crops & Usage	Zire	Diadieme	Bountou Batt
Average CH revenues per household (HH)	1,377,000FCFA ³ (\$2503)	768,000FCFA (\$1,396)	345,000FCFA (\$627)
Diversity of CH crops	High diversity: <ul style="list-style-type: none"> 68% of HH cultivate onions, turnips and carrots. 32% HH cultivate onions only 	Low diversity: <ul style="list-style-type: none"> 86.6% of HH cultivate onions only 13.3 % of HH cultivate onions, carrots & eggplants 	High diversity: <ul style="list-style-type: none"> All HH cultivate cabbage, eggplants and okra.
Usage of CH revenues	76.5 % of HH: <ol style="list-style-type: none"> Food Supply Building materials Fishing materials Goats or sheep 	85% of HH: <ol style="list-style-type: none"> Food supply Paid debt accrued from fishing and food purchase Building materials 	80% of HH: <ol style="list-style-type: none"> Paid debt accrued from fishing and food purchase Finance rice production

³ At the time of the study \$1 = approximately 550FCFA (West African Franc)

We found that seasonal engagement in CH improved the food security of most fishers in Zire and Diadieme by giving most fishers the income they need to purchase food supply to last them during the months when fish stocks are low and income from fishing is not sufficient to meet minimum food consumption needs (see Table 3). About 76.5 and 85 percent of respondents in Zire and Diadieme respectively claimed that their first priority for CH revenues was to purchase enough food supply such as rice, cereal, oil and beans that will last for 2 to 3 months. When asked what helped most, between CH and rice, in terms of helping get his family through the most difficult months, a fisher in Diadieme replied:

“They are both helpful. But the onions help us a lot when the river is not good. You have to stock food supply and manage it carefully until you are able to make more money from fishing to buy food and other expenses. You have to organize yourself very carefully with what you have from the onions. It's like a patchwork where you put things together until the hardship is over.”

Nevertheless, 23.5 and 15 percent of households in Zire and Diadieme claimed that the amount that they received from CH was not enough to buy food supply to last them the whole 3 months when fish stocks are low. These households accrued a lot of debt to buy food supply in the previous months and had to repay it after their harvest. As a result, the amount of debt that they accrued was an impediment to their capacity to purchase enough food for the entire low fishing season.

In Bountou Batt, on the other hand, seasonal engagement in CH among most fishers did not improve their food security. Around 80 percent of households interviewed

in Bountou Batt claim that all the money they earned from gardening, was used to pay debt accrued from fishing activities or used to finance their rice production, therefore they did not have enough money to buy food supply. For example, a fisher noted “All the money from the onions goes back to the coxer. If you don’t pay it all then he won’t lend you any more money.” Therefore, it is important to note that engagement in CH improves food security only for those that had high CH revenue and did not have high levels of debt. Households with lower CH revenues and higher levels of debt did not report much improvement in food security as a result of engaging in horticultural activity. Thus, low levels of income generated from alternative activities coupled with high levels of debts accrued by fishers can preclude the positive outcomes of diversification on the household’s food security.

4.6.4.b. Access to nutritious food

In terms of nutrition, engaging in CH improves the nutrition of the community overall by making nutrient-rich food such as fresh fruits and vegetables available within the villages. This is important especially for communities that are isolated and located far from markets, like Zire and Bountou Batt. Indeed, many fishers interviewed reported easier access to fruits and vegetables to complement their daily diet as an advantage of having horticultural parcels in the communities. Buying fresh fruit and vegetables from nearby markets is very expensive and only households that had access to transportation could go there. A spouse explains the advantages of having horticulture parcels in the village:

“If it was not for the gardens in this village some of us would not have all the ingredients we need for our meal...it would be just plain rice and fish...not everyone has the means to go out to Ross Béthio [nearest town located at 18km] to shop for our meals. Besides you have to sample your vegetables before you sell them [laughs].”

Thus, many often walk to these parcels to seek fresh vegetables and fruits. During the harvest, women offer their assistance in exchange for a bag of onions, cabbage, carrots and other produces. In almost all of the parcels that we visited in all three communities, the fishers have a small section where they can grow crops for household consumption. Others also gave their wives some of the vegetables to be sold within the villages. Therefore, the production of CH as an alternative occupation in these fishing communities improved the nutrition of local households by making nutrient-rich food locally available.

4.6.5. Other household level factors affecting livelihood security

In addition to the factors that were determined by the chosen framework, our data revealed other factors that are important to understand why farming as a diversification strategy lead to livelihood security for some households and not others. These include the targeted fish species, risk associated with farming, asset profile and access to resources.

4.6.5.a. Fish species targeted

In each community, fishers targeted different types of species. This has an implication on the level of debt that these households accrued and how they used their

earnings from farming. Consequently, it is important to understand how the species that fishers choose to target affect their livelihood security. Targeting species such as the Nile Perch (*Lates Nilotichus*) requires special and expensive equipment. The cost of a single driftnet for the Nile perch is estimated at 180,000FCFA (~\$327) at a time of the research. Fishers who chose this strategy had to borrow from fish traders to purchase the equipment. In Bountou Batt, all fishers who were interviewed explained that they targeted the Nile perch. This left them highly indebted towards their fish traders. Consequently, their revenues from farming were used towards repaying their debts.

On the other hand, fishers in Zire and Diadieme specialized in smaller fish species such as the catfish (*Clarias Gariepinus*), the yellow mullet (*Mugil Cephalus*) and the Nile Tilapia (*Oreochromis Nilotichus*). Because of the proximity of these communities to Saint Louis, the regional capital, where the demand for smoked catfish is high, fishers believe that specializing in these species rather than targeting the Nile Perch is a better economic decision. Therefore, fishers in Zire and Diadieme invested a lot less in fishing equipment and accrued less debt than those in Bountou Batt. As a result, they were able to allocate their farming revenues into other household expenditures. While for some fishing a household, farming was used to supplement their income from fishing, for others it was a source of financial capital to invest in their fishing equipment. These findings suggest that depending on the specialization of the fisher (i.e. target species), farming may or may not serve as a strategy to enhance the income and food security of his household.

4.6.5.b. Risk associated with farming

In terms of risks associated with farming (see Table 8), it is important to first note that most fishers reported increasing debt accrued oftentimes directly associated with rice production. In Diadieme and Bountou Batt, fishers indicated that the level of debt accrued from the bank to finance this activity and the multiple expenses associated with harvest were the most significant risk factors. There were several accounts from interviewees noting how most of their harvest earnings were used to pay back their debt and didn't make any profit as a result. More specifically, the risk in this endeavor is associated with weather related factors. Rainfall variability is a growing risk factor, which may lead to lower yields in the future. Villagers noted that precipitation have decreased over the years. In 2015, the rainy season started in this region of the country much later (late July) than usual, which left many producers, worried about their production.

About 40 percent of fishers reported crop failure as a major risk factor. Most of these fishers have experienced crop failure in the past few years and lost most of their capital investments in didn't receive any profit from this activity. Of these respondents, 60 percent reported crop failure due to water salinization. A fisher in Zire recalled losing all of his investment in horticulture in the previous year because the water from the well on his parcel is now salinized. As a result, he had to rely on his relatives to bail him out of the debt he accrued and help his family with food purchase. He now rents out another parcel and can no longer use his own. Over the past decade, water salinization is the

second most significant environmental issue with major impacts on the irrigated agricultural lands in this region (PLD Diama, 2010).

Market prices for horticultural commodities such as onion are the third most significant risk that fishers reported. Between May and June 2015, the price of onion dropped by half because of the increase in supply. Producers in Zire who harvested in May enjoyed higher prices than those in Diadieme who harvested in June.

Table 8. Most significant risks in farming.

Type of risks	Frequency	Percentage
Debt accrued*	45	43.3
Crop failure**	42	40.0
Market prices	29	28.0
Risk related to farm worker***	9	8.8
Access to market	7	6.6

**Mostly associated with rice production*

***Causes of crop failure included water salinization and insects for horticulture and lower and unpredictable precipitation rates for rain-fed rice production.*

*** *Some farm workers abandon the farm without warning thereby disrupting horticultural production.*

Therefore, many households in Diadieme sold their onions at very low market prices and as a result received lower revenues. While some households saw their produce perish because they were holding them waiting for market prices to rise, others ended up making very little profit to none because of low prices. Therefore, the volatility of market prices represents a risk for CH producers that can either play at their advantage or significantly reduce their revenues thereby affecting their livelihood security.

4.6.5.c. Asset holding and access resources

Household level decisions about resource allocations are made based on its asset profile and capacity to access resources (Allison & Horemans, 2006). Therefore, it is also important to evaluate how the level of assets that household has in their possession influences their livelihood security. Our findings reveal that livestock holding that households have in their possession was an important factor. Furthermore, a household's access to land, technology, and manpower also affected their decisions on the diversity and types of crops they chose to farm.

In Zire, we found livestock to be significant for their livelihood security. Household in Zire complement their fishing and farming income with livestock holding, mainly goats and sheep. They explained the importance of small livestock for their livelihood security. The number of livestock holding per households was about 38 goats and 2.6 sheep. Goats, sheep and other small ruminants were sold when households were in need of cash and could not access it through other activities. This happened especially during a time when the flow of income from fishing was at its lowest and farming revenue had not been collected yet. Therefore, livestock was a form of savings that they could access and served as a safety net during the low fishing season thereby providing an alternative source of income while waiting to collect farm revenues. In Diadieme and Bountou Batt, on the other hand, households owned an average of 4 goats and 1 sheep. Because of the small number, livestock was mostly used as a source of income of last resort in case of extreme emergency such as illness or death in the family. Therefore,

unlike in Zire, most households in Diadieme don't have a productive asset that can fulfill an important safety-net function like livestock.

Finally, fishers reported that access to land, technology and manpower determined the choices of crops they cultivated. For example, in Bountou Batt, fishers explained that they have very small cultivable parcels (0.4 hectares/Household), and lacked the manpower to cultivate more lucrative crops, such as onions, that require more space and labor. As a result, most households decided to cultivate shorter cycle crops that provide frequent but smaller income. In Diadieme and Zire, households have access to larger parcels (at least 1 hectare/Household), but because of lack of financial and labor capital, their capacity to diversify their crops is very limited, thus they choose to maximize their revenue.

4.7. Discussions

The multidimensional approach to understanding how diversification in fishing-farming communities affects the livelihood security of households enabled us to uncover some important factors and processes underlying this relationship. These factors and processes were often overlooked in previous studies. As a result, they often provided a misleading picture of fishers' livelihoods in which economic diversification automatically reduced vulnerability to resource fluctuation. Based on our findings there are key aspects that influence the relationship between fishing, farming and livelihood security including: the timing and frequency of income, the type and diversity of crops, access to land, technology and labor, level of debt, and livestock holdings.

First, timing and frequency of income from farming is of great importance in shaping the income security of fishing-farming households. Several studies have examined the economic impact of diversification in fishing communities with special attention to the role of farming in complementing fishing income (Geheb & Binns, 1997; Morand et al., 2005; Olale & Henson, 2013; Martin et al., 2013). However, unlike our study, none of them account for the timing and frequency of income from this alternative occupation. For instance, Olale & Henson (2013) found a higher income level for fishers involved in farming, but they failed to explain the effects of timing and frequency of farming income on their ability to cope with fishing resource fluctuations. Yet, an important condition of livelihood security is to overcome the mismatch between household consumption and uneven income flow caused by seasonality (Ellis, 1998). Thus higher income level does not always translate to income security if revenues from farming are not synchronized with household consumption needs. In our study, we found that households in Zire were able to control the frequency of farming which allowed them to achieve income security.

Identifying and addressing the factors that affect the timing and frequency of income from alternative occupations is a productive step towards improving income security of fishers. For fishing-farming communities, our study reveals that those factors include the type and diversity of crops that households choose to cultivate. Furthermore, our study highlights that not all forms of agriculture lead to income security. Seasonal agricultural productions, such as horticulture in this study, that alternate with fishing

seasons, provide a more even income flow throughout the year thus enhancing household security.

Our findings also indicate that decisions regarding the type of agriculture and crop diversity depend on the households' access to resources. We found that the size of farming land, financial capital, farming technology and labor available to the households were all determining factors in their choice of farming and crop diversity and ultimately affected household security. Household decisions regarding what types of farming to practice and the crops to cultivate were made based on access to these resources. Therefore, there are considerable tradeoffs between the amount of farming revenues and frequency of income for households who didn't have access to sufficient resources to capitalize on their diversification strategy. This confirms the importance of access to land and financial capital to ensure a successful income diversification among fishers (Allison & Ellis, 2004; Brugère et al., 2008). To this, we would add that farm labor is also a crucial factor in deciding which crop to cultivate and ultimately shaping the income security of fishers.

The issue of informal debts is prominent in fishing communities (FAO, 2005; Mills et al., 2009), yet it has not been examined in the context of diversification. Our study provides evidence that high level of debts accrued from fishing material precludes positive outcomes of diversification in fishing communities. We found that higher debt levels precluded household's capacity to achieve food security and to invest in productive assets. Most debt was accrued from the purchase of fishing gears. Chiwaula et al. (2010) found that in Nigeria and Cameroon higher value fishing gears led to an

increase in mean household income and decreases income variance. However, we suggest that debt accrued to purchase the fishing gears can also decrease income security of households. An alternative explanation may also be that farming revenues in full-time fishing communities such as Bountou Batt are used to finance the fishing activities rather than a coping mechanism. While this premise may be true, we can also argue that this strategy precludes the livelihood security of fishing households.

Finally, it has been suggested that livestock holdings have a risk-decreasing effects on rural households because it is used as a buffer against income fluctuations (Chiwaula et al., 2010). Furthermore, research shows that livestock acquisition plays an important role in lifting households out of poverty and providing safety nets to keep them from falling back into poverty (Kristjanson et al., 2004; Smith et al., 2013). The analysis across all three communities in our study highlights these previous claims about the importance of livestock in ensuring livelihood security. While Morand et al. (2005) suggest that complementing fishing with farming is a safer strategy than being a full-time fisher, we would add that alternating between fishing and farming while keeping livestock is a strategy that will most likely lead to livelihood security.

In addition to the factors we uncovered, there are two topics that have been overlooked in the literature on diversification in fisheries that our study indicate to be of great importance for future research: the contribution of diversification on the nutritional security of households and communities, and the risk associated with alternative economic activities. In terms of nutritional security, this is a topic that is overlooked in the fisheries research, yet health issues are ranked amongst the most important sources

of vulnerability (Béné & Russell, 2007; FAO, 2007; Mills et al., 2009). Improving access to nutritious food can be a step towards reducing health risks in fishing communities. Our finding highlights the relevance of nutritional security when assessing the social outcomes of diversification among fishing households.

Ellis (2000) insists that in order for diversification to reduce vulnerability, the risk factors for the different activities should not be the same. In other words, the factors that create risk in CH (i.e. crop failure, market prices) are not the same as those creating risk in fishing (i.e. seasonality, cyclical resource fluctuations). Furthermore, when the activities rely on different ecosystems, diversification as a risk spreading strategy becomes even more effective. In our case, CH and fishing rely on very different ecosystems (i.e. land and river systems). Therefore, in terms of livelihood security, complementing fishing with CH is an effective strategy to ensure that total household income is at least maintained when one activity fails to provide sufficient income. Moreover, fishers noted more constraints and risks with CH than with fishing. This highlights the fact that risks and constraints related to fishing are often not considered a major source of vulnerability among fishers compared to other non-fishing related constraints, especially access to land or credit for farming activities (Mills et al. 2011). This indicates that non-sectoral interventions can have a more effective impact than those targeting directly the fishing sector.

4.8. Conclusions

This study sought to understand how livelihood diversification affects the livelihood security of fishers in three communities of the Senegal River Delta. More specifically we examined how farming complements enhances the different dimensions of livelihood security. This has allowed unveiling the factors that precludes or enhance the livelihood security of households. A main of contention in this study is that even though farming reduces the poverty of fishing households, this form of diversification does not necessarily lead to more secure livelihoods. Unlike past studies that mostly focused on the effects of diversification on income levels (Olafe & Henson, 2013), the framework that we applied helps uncover some key aspects that shape the relationship between diversification and the livelihood security in fishing-farming communities. Our framework is more comprehensive in the sense that it captures the multiple dimensions of poverty and vulnerability by deconstructing livelihood security. It also explains what household level factors and processes preclude or enhance livelihood security through its different dimensions. These provide strategic points of entry for development programs centered on reducing vulnerability by strengthening the diversification processes in fishing-farming communities.

There are several main points that can be extrapolated from this study for fishing households who engage in farming as a diversification strategy:

- The diversity and type of crops determine the level, frequency and timing of income. Therefore, crop diversity influences the income and food security of fishing-farming households.

- However, access to land, technology and manpower shaped the decisions about crop diversity.
- The household level of debt shapes the positive outcomes of diversification on both income and food security.
- Higher livestock holding strengthen the relationship between diversification and livelihood security.
- Interventions focused on reducing risks associated with farming will be effective in enhancing the livelihood security of fishing households.

CHAPTER V

BETWEEN FISHING AND FARMING: FISHERMEN, WOMEN AND PROCESSES OF LIVELIHOOD DIVERSIFICATION IN THE SENEGAL RIVER DELTA

“I’ve become a farmer, but fishing is what I will always know best, because for a long time that’s all our ancestors had.” (Fisher in Diadieme, Senegal)

*“God made that our onions and turnips are ready when there are no more fish in lake.”
(Woman in Zire, Mauritania)*

5.1. Overview

Fishing households in Africa often engage in farming activities as part of their livelihood diversification strategy. Scholars recognize that the participation of both men and women in farming production is an important component of sustainable fishery systems. However, little is known about the processes that shape how households in fishing communities participate in farming production. Using the case study of two communities in the Senegal River Delta, this paper describes how men and women arrange their social relations to access and organize the resources they need to participate in horticultural production. Additionally, the paper explores the social structures that shape this diversification process.

Findings reveal that labor organization is key to effectively balance fishing activities and horticultural production. Thus social relations are structured around this aspect. The fisherman typically hires a farm worker who plays an important role in this regard. The paper describes the various forms of relationships between the farm worker

and the fishermen and how these are structured around the limitations of the former. The findings also show that there are gender-based factors that shape how women access and organize their labor. Women have limited control over their own work and less latitude in recruiting labor. As such they tend to negotiate their relations with other women to overcome such constraints. In terms of the social structures within which these processes take place, findings show how over several years, externally driven projects have expanded their social networks, transformed their social relations and the local structure within which the diversification process is happening. Moreover, economic policies and limited access to credit constitute broader structural constraints that have affected their participation in horticultural production. In the end I provide some recommendations to inform more carefully designed livelihood diversification strategies for sustainable fishery systems.

5.2. Introduction

For many men and women in African inland fisheries, the uptake of farming activities during the low fishing season is a critical aspect of their livelihoods. Such form of livelihood diversification is an adaptation strategy to resource fluctuations. It is intended to provide a consistent income and food production system (Geheb and Binns, 1997; Morand et al., 2005). From a resource management perspective, farming also plays a role in the sustainability of fisheries. This is because the participation of fishing households in farming activities influences their decisions about how to exploit fishery resource. Such decisions include whether or not to stop fishing when fish stocks are low

(Sene-Harper, Matarrita-Cascante & Arantes, forthcoming), and how fishers react to regulatory policies (Cinner & Bodin, 2010). Therefore, the uptake of farming activities by fishers is frequently viewed as an integral component of sustainable fishery systems (Ellis & Allison, 2001; Sarch, 2001).

Thus, there is a clear recognition of the role that farming plays in resilient fishing livelihoods as well as the sustainable management of fishing resources. What we know less about is the processes that enable households in fishing communities to participate in farming. That is, while there is plenty of research noting the benefits of livelihood diversification through farming in fishing communities, much less is known about how households make decisions in farming production. In this paper, I address this shortcoming by exploring the underlying processes associated with the participation in farming among men and women in two fishing communities of the Senegal River Delta. More specifically, I focus on 1) how men and women structure their social relations to access and organize the resources they need in this livelihood diversification process as well as 2) exploring the intervening social structures.

This work is justified by the assertion provided by scholars noting that policies that seek to support resilient livelihoods need to be built on a better understanding of the processes which encompass the agency people exert in negotiating their adaptation strategies (Coulthard, 2012) and the structures that shape such agency (Nygren & Myatt-Hirvonen, 2009). Further, as suggested by Crawford (2002) and Brugère et al. (2008), I believe that such understanding should be sought independently for men and women. This is because in addition to the role that men play in providing for the household

income, women significantly help sustain this income by engaging in activities outside the fishing sector (Brugère et al., 2008; Crawford, 2008). However, the way these two actors achieve this is different, as gender-based differences have been shown to deeply influence the outcomes and processes of livelihood diversification (Kabore & Holvoet, 2006 quoted in Brugère et al., 2008). Thus, as noted by Wooten (2003) and Bennett (2005), such differences shape men and women's participation in diverse income generating activities.

This study is situated in the Senegal River Delta (SRD), where many fishing communities have turned into farming partly because of reduced access to fisheries resources. This reduction is the result of ecological mutations of the river systems combined with conservation policies in the region in the past two decades. Since households turned to commercial horticulture⁴ to complement their fishing livelihoods, horticultural production has more than doubled in the communities under study (Touyer et al., 2012). The study intends to answer the following questions: 1) How do fishermen and women organize their social relations to access the resources they need to participate in farming? and 2) How do social structures shape fishermen and women participation in farming activities?

The chapter is structured as follows. I first review the literature focusing on the role of farming and women in building sustainable fishing livelihoods. I then discuss the actor-structure approach to understanding livelihood strategies as our theoretical

⁴ Commercial horticulture is the production of fresh fruits and vegetables as cash crops. These crops are grown on an area typically on less than 2 hectares.

framework. This is followed by our research methods, results and discussion. I finish this paper with implications of our findings and some concluding remarks.

5.3. Literature Review

5.3.1. Farming and sustainable fishing livelihoods

Complementing fishing activities with farming remains the most common livelihood diversification strategy in fishing communities, particularly in West Africa (Morand et al., 2005). This is because fishermen perceive it to be a safer livelihood strategy than being a full-time fisher. Morand et al. (2005; p. 76) contend “the farmer fisherman produces his own domestic needs in cereals and can thus feed his family without depending on the market. By contrast, the migrant professional fisherman is exposed to a larger number of risks of all kinds.” Geheb & Binns (1997) provide the most detailed account on the relationship between fishing and farming. They maintain that this livelihood strategy is based on local coping mechanisms involving the production of varied sources of food in different points in time. As such, for many households who live by inland lakes, fishing and farming has become inextricably linked to achieving household food security (Geheb & Binns, 1997). Additionally, farming also provides an extra source of income for households. For example, Olale and Henson (2013) found that in Lake Victoria, Kenya, fishers who also engaged in farming earned a higher cash-income than fishers who depended exclusively on fishing. Therefore, agriculture in fishing communities improves both food and income security by providing

households food supply and supplementary income to maintain their well-being throughout different seasons.

From a resource management perspective, the link between the engagement in farming and lower fishing pressure can be drawn from studies on livelihood diversification and sustainable fisheries management. Brugère et al. (2008) claim that diversification among fishers is a characteristic of a sustainable fishery system. This is because diversification can reduce pressure on fishing resources in times of scarcity or diminishing economic returns by giving an opportunity for fish stocks to recover (Jul-Larsen et al., 2003). Furthermore, the capacity of household members to engage in off-season farming activities has been shown to influence fishers' decisions to remain or stop fishing when fish stocks are low (Sene-Harper, Matarrita-Cascante & Arantes, forthcoming), and how they react to the fishing regulations that have been implemented (Cinner & Bodin, 2010).

5.3.2. Women in fishing communities

In recent years, the role of women in sustainable fisheries management has become an important theme of discussion in the literature (Williams et al., 2012; Santos, 2015; Kleiber *et al.*, 2014). Women occupy a central place in fishing-dependent communities, but the diverse forms through which they contribute to fisheries livelihoods are only starting to emerge (Santos, 2015). Traditionally, women in fishing communities have occupied the post-harvest functions such as trading and processing of fish products (Bennett, 2005). However, recent studies have shown that women are not

limited to post-harvest occupations only. For example, both Santos (2015) and Kleiber et al. (2014), found that in Brazil and Philippines women also participate in capture fisheries, extracting shellfish from near shore habitats using traditional methods. This form of fishery capture, which is distinct from men, allows women to simultaneously supervise children (Santos, 2015).

Furthermore, other studies show that women are engaged in a broader range of activities including those outside the fishing sector. The involvement of women in off-season farming activities is of particular importance, because it helps sustain income flow at the household level (Kabore & Holvoet, 2006 quoted in Brugère et al., 2008). Additionally, the engagement of women in off-season activities influences fishers' decisions about whether or not to fish when fish stocks and economic returns are low (Sene-Harper et al., forthcoming). Thus, it is becoming clearer that the engagement of women in farming activities during the low fishing season is key for the livelihood security of fishing communities.

There are, however, specific factors shaping the patterns of women participation in different income generating activities that place them at disadvantage over men. Bennet (2005) reported different forms of vulnerability for women in fisheries across various West African countries that affect their capacity to effectively engage in economic activities. She noted that in Gambia for instance, women were limited in their capacity to organize themselves. This in turn affected the amount of support (e.g. financial and training) they are able to receive from NGOs. Wooten (2003) also noted a gender-biased system of commercial gardening production processes in rural Mali. He

explained that women faced constraints in terms of access to farming land and had little control over the way they allocate their time between household chores and external activities (Wooten, 2003). In this article, I describe how women structure their social relations to overcome some of the limitations they face as they participate in horticultural productions and how this process differs from men.

5.4. Theoretical Framework: Actor-Structure

We draw from DeHaan (2000) actor-structure livelihood framework to examine the processes of diversification that is taking place in fishing-farming communities of SRD. DeHaan departs from the actor-centered scholarship on rural livelihoods (c.f. Sen, 1981; Chambers & Conway, 1992) that focus on the ability of people to construct their livelihoods. In such approach, the actor (e.g., household, individual) decides on a choice of livelihood strategies on the basis of his/her ability to access resources and tangible assets (Chambers & Conway, 1992). While this orientation is important, it isn't sufficient to understand the broader socio-economic processes that shape the choices people have and the constraints they face in their pursuit for sustainable livelihoods. Therefore, the actor-structure framework becomes more realistic, notably for its recognition of structural bottlenecks and barriers (DeHaan, 2000). In this framework, livelihood strategies result from the influence of individual agency, but may also change as a consequence of external factors, According to DeHaan (2000; p. 349):

“Agency refers to people’s capacity to integrate experiences into their livelihood strategies, and seek outlets for ambitions and solutions to problems [...] Agency is embodied in the individual, but embedded in

social relations through which it can become effective. Individual choices and decision-making are embedded in values, norms and institutional structures [...] Actors, both individuals and social groups, influence structure through agency. Therefore, agency is the hinge between actor and structure.”

For the purpose of our study, we draw two critical aspects from DeHaan’s above interpretation: the fact that agency can only function through social relations, and that structures shape and are shaped by agency. That is, social relations enable or hinder people’s access to important livelihood resources (Allison & Ellis, 2001). According to Long and Long (1992), effective agency requires organizing capacities through the manipulation of a network of social relations. As such, by manipulating social relations, individuals are able to also shape the social structure within which they participate in economic activities (DeHaan, 2012). Thus understanding how people exert their agency requires an understanding how individuals manipulate their social relations to overcome the adversities they face. However, factors such as gender, race, and ethnicity determine the forms in which actors interact with each other as the basis of their relations. For example, men and women face different limitations to their access to resources. As such, they each have their own ways of negotiating social relations as a mean of overcoming the adversities.

Livelihood strategies are embedded within broader socio-economic contexts (Nygren & Myatt-Hirvonen, 2009). The structure constitutes the contextual factors at different levels that interact with individual’s agency and the outcomes of their livelihood strategies (DeHaan, 2012). They include macro-level trends (e.g. national

policies, market prices, technological trends), local trends (e.g. local institutional changes) and shocks (e.g. environmental disaster). As such, we must understand structural factors at different level that influence both the individual decision-making and the outcomes of their livelihood strategies (Ellis and Allison, 2001).

Grounded on this framework we seek to understand the way in which individuals in the fishing communities under study organize their social relations as they participate in horticultural production. We also examine the structural constraints that shape their agency in this process. In the next section, we describe the methods that we used to gather and analyze this information. This is followed by our result and discussions where we start with a description of the environmental changes in the Senegal River Delta that have caused livelihood changes as well as a brief description of this mix fishing-farming practices.

5.5. Methods

5.5.1. Site context: Environmental changes in the Senegal River Delta

This study was carried in the Senegal River Delta (SRD) located in the Sahel region of Senegal and Mauritania. The people who live in SRD explain that the dry climate combined with lower precipitations, makes life in this area, very difficult. The dry climate of the region has been aggravated by long periods of droughts in the 1970s. In addition to climate related changes, local communities have experienced different environmental and economic policies since the 1970. These policies lead to significant

and irreversible shifts in the social and ecological landscapes thereby causing shifts in livelihood practices for various social groups including fishers.

Beginning in 1971 the area was targeted for fishery resources conservation through the establishment of several protected areas in what is today known as the Transboundary Biosphere Reserve of SRD. Consequently, fishing activities have been drastically curtailed in those areas impacting the livelihoods of fishers who inhabit the region. Moreover, the government of Senegal built the *Diama* and *Manantali* dams, all completed in 1988, in order to develop irrigated agriculture in the region. The dams had severe negative impacts on local ecosystems, including the intrusion of invasive aquatic vegetation, declines in the water levels, and changes in the water flow regime, all of which reduced the fish stock in the river systems and connected flood plains (Magrin & Seck, 2009; Ndiaye, 2001).

Despite the conservation policies put in place and the ecological changes on the river system, the area continues to be the main supplier of fish for markets in the major regional cities (Magrin & Seck, 2009). Yet these changes have had deep impacts on the livelihoods of fishermen, who increasingly have to rely on farming as a complementary activity in order to adapt to these mutations.

5.5.2. Fishing-farming livelihoods in the Senegal River Delta

In the Saint Louis region alone of SRD, where our study takes place, close to 25,000 households are involved in fishing-based activities (e.g. capture, processing and trading) among which, fishing is the main source of income for most. Most men in the

fishing sectors (more than 90%) are involved in capture activities. This activity is carried in groups but there is no redistribution or sharing of catches between group members. Unlike many other fisheries in developing countries (Kleiber et al., 2014; Santos, 2015) women in SRD are not involved in any form of capture activities and are mostly involved in the post-harvest activities. About 23% and 63% of women in the fishing sector are involved, respectively, in fish transformation and commercialization (UEMOA, 2013). Meanwhile, farming constitutes the second most important livelihood activity for men and women in the fisheries sector, more specifically, rice-production and commercial horticulture (UEMOA, 2013).

Over the past decade, however, commercial horticulture (CH hereafter) is surpassing rice-production as a complementary activity in these fishing-dependent communities. Commercial horticulture is the production of fruits and vegetables as cash crops. Apart from the increasing risks associated with the production of rice (i.e. shorter rainfall, unfavorable agricultural policies), fishermen indicated two other major reasons for their growing interests in CH. The first one being that CH has now become a very lucrative venture. Second, the production and harvest seasons of major horticultural commodities (i.e. onions and sweet potatoes) coincide with the low fishing season when economic return and catch rates are at their lowest level. Therefore, CH is well integrated into fishing livelihoods allowing households to balance both activities while meeting their needs for food and income throughout the year.

5.5.3. Site selection

This study takes place in the fishing communities of Diadieme and Zire, located around the Transboundary Biosphere Reserve of the Senegal River Delta, respectively in Senegal and Mauritania. In this article, I chose to focus on these two communities, first because fishing households in both localities engage in farming activities as part of their livelihood diversification strategy. Additionally, both have similarities in the types of livelihood changes they have experienced and the time frame during which this was happening. Such changes include a sharp increase in commercial horticulture production since early 2000 (Touyer et al., 2012). Furthermore, since 1994, NGOs and local governments have implemented various projects to improve the livelihoods of fishing households in Zire and Diadieme. Since 2008, commercial horticulture projects were specifically designed to increase the participation of women in this activity in both communities.

5.5.4. Data collection and analysis

The data used in this study comes from a 10-months period of field study between 2014-2015, during which I split most of time between Diadieme (in Senegal) and Zire (in Mauritania). I used a combination of qualitative and quantitative methods to gather information for this study. The main data collection instrument includes 84 interviews with head of households (n=44 in Diadieme and n=40 in Zire). Purposive sampling was used to target households that mentioned fishing and farming as first and second most important sources of income. The data collection process consisted of two

steps. First, some baseline socio-economic information was gathered through closed-ended questions form which I derived the quantitative data. The information that is relevant for this chapter include the amount farming revenue, whether or not they employed a farm worker. Second, semi-structured interviews followed and included questions about income pooling among household members, organization of labor, household access the resources needed to farm.

In addition to the household interviews, I included open-ended questions for the 17 women who participated in this study and 3 leaders of women associations. The purpose of these questions was to understand the major limitations they faced as they try to participate in diversifying their economic activities, their participation in farming production and their work in collective settings with other women in the community.

Moreover, because I spent many days and nights in these communities, shared meals with families and carry informal conversation with local people, I was also able to enrich this data through observation of how they organized their daily farming and fishing activities and household chores. I visited very often the different horticulture parcels and carried discussions with farm workers. Finally, the data was complemented with secondary data from technical reports and governmental documents.

Most interviews were conducted by me in Wolof (the main local language), or in Moorish (spoken by the Moors) with the help of a local translator who was recruited from the village. The translation happened from Moorish to Wolof. I am fluent in Wolof and French.

The interviews were translated from Wolof to English and transcribed by me. Field notes were reported in English and transcribed also by me. The qualitative data was analyzed through a directed content-analysis approach (Hsieh and Shannon, 2005), which allowed the analysis and interpretation of data guided by the concepts under study (defined by the research questions and detailed in each of the articles included in this dissertation). Using this approach, the concepts under study are used to guide the initial coding. However, during the data analysis, the researcher allows underlying themes to emerge from the data for a deeper analysis of these concepts (Hsieh and Shannon, 2005). The quantitative data was analyzed using basic statistical tools on Microsoft excel. Most of this data was descriptive and used to calculate average farming revenue per household, frequencies and percentages.

5.6. Findings and Discussions

5.6.1. Social relations

5.6.1.a. The fisherman and the farm worker

There are inevitable trade-offs in terms of labor time as households seek to combine fishing and farming activities (Martin *et al.*, 2013). Because of this, an effective organization of labor is a key element to livelihood diversification (Ellis, 2000). My findings revealed that the relationship between the fisherman and the farm worker is the foundation of an optimal organization of labor that is centered on the former's level of farming experience and daily needs for food and income.

In SRD, farm workers are seasonal migrants from Guinea or other regions of Senegal and are regarded for their experience working in farms and their labour power⁵. Locally known as *sourga*, these migrants represent a pool of labor for small farm holders who lack the household labor availability and appropriate farming knowledge. In fishing communities where CH is a relatively new activity, many fishermen have not acquired substantial experience for horticultural production. In those cases, the *sourga* not only provides his labour power but also his expertise to the farm holder. Therefore, the fisherman's experience in horticulture production influenced the decisions on whether or not to hire a *sourga*, and his responsibilities.

People in Zire have been engaged in CH, since the 1990s, and thus have acquired substantial experience. In Diadieme on the other hand, CH is a relatively new endeavor (starting in 2010), which explains why fishermen there often look to hire *sourgas* in order to gain more knowledge about farming. In Zire about 40% (16 out of 40) of the fishermen who were interviewed hired 1 to 4 *sourgas* – all of them as laborers. In Diadieme, they all hired 1 to 2 *sourgas* and 70% (31 out of 44) employed them as farm managers. CH productions are twice higher in parcels that had at least one *sourga* and three times higher in those with at least two *sourga*.

For most households fishing absorbs the largest proportion of labor time. In Diadieme particularly, fishermen practice fishing and farming simultaneously even during the low fishing season. Several fishermen in this community have explained that

⁵ We refer to labor power as the capacity to do laborious work. The physical capability of doing heavy manual work is the defining characteristic of a migrant farm worker.

ceasing fishing activities, could compromise the household food and income security. As one noted: “If you don’t fish today, you will not eat today”. The role of the sourga on the farm has implications on how fishermen allocate their time between both activities. If the sourga is hired as the farm manager, the fisherman can continue fishing. However, if the sourga is hired as a laborer then the farm owner (i.e., the fisherman in this case), has to supervise the operations and therefore spend more time on the farm (thus decreasing time spent fishing). Geheb and Binns (1997) also note that in fishing communities around Lake Victoria, farm workers “relieved them [fishers] from farming duties and permitted their greater concentration on fishing” (p. 89). Thus these findings reveal the different forms of relationships between the fisherman and the farm worker and how they are structured around the limitations and the daily needs of the former.

5.6.1.b. The social relations of women in horticultural production

A key factor in maintaining the livelihood security of fishing households is the economic contribution of women. In diversified households like the ones studied here, women as in the case of men, engage in economic activities outside the fishing sector like farming in this case. However, women face gender-based differentiations in their capacity to access and organize labor as they participate in farming production (Wooten, 2003). These are described below.

Limited access to labor

In Diadieme and Zire, women were not directly excluded from participating in horticultural production. However, they had little control over their own labor and that of

others. This is because most of women's work is directed at household maintenance and thus have by far less time than men to participate in farming production. Moreover they have less latitude in recruiting farm workers. This is not the case for men, who usually directly negotiate with the farm worker. Some men reported to travel to the nearest town that serves as a regional hub seasonal workers seeking farm work to recruit their sourga. However, women typically rely on a male household member (e.g. spouse or elder son) to find them a reliable sourga. Some reported that they could not participate in horticulture production because they couldn't find a sourga. A woman recollects:

“I have not been able to cultivate any onions this year because I couldn't find a sourga. My son usually finds one for me but he travelled this year. I had to lend my parcel to my nephew. The only work I can do until the fishing season starts again is petty trading.”

A larger proportion of men (58% or 49 out of 84) than women (28% or 5 out of 17) who were interviewed reported to have at least one sourga. As I indicated previously, labor is a key input in dry-season horticulture production. This is reflected in average the CH revenues for women (\$979) than men (\$2503) in 2015.

Organizing labor: From cooperatives to women gardening groups

Over the years there has been several livelihood projects implemented in fishing communities in the SRD. As a result, several community level cooperatives for men and women were established to support the implementation of these projects. These were formed to support each member's livelihood' activities, and facilitate the economic diversification out of the fisheries sector through micro-credit schemes, training in

horticultural production and labor support. Diadieme and Zire have two cooperatives each, one for men and one for women. The men cooperative has about 100 members each who are almost all fishermen. The women cooperatives have 25 members each including fish processors.

The women cooperatives in Diadieme and Zire are officially recognized in technical reports. However, they have not been able to sustain the support for horticulture production they were set to up to provide to its members. At the beginning the members participated in training sessions about horticultural techniques and received a start-up fund to exploit a collective horticulture parcel of 2 hectares. Under the agreement, they were each supposed to contribute in terms of labor input and the revenues be split between all of them. However, the cooperative parcel was exploited for only 2-4 seasons and until this day has not been functional. According to cooperative members, it was very difficult to have all 25 members to contribute equally. The representative of the cooperative mentioned the difficulty of getting organized in part due to the amount of work that women have in their households, which give them little time outside of their homes. Although many contributed their labor time to the garden, not all were able to do the same in a way that was perceived as fair. One woman explained:

“It’s difficult to work with so many women in this village. It gets too complicated and we start arguing [...] Why is it that me Awa, I leave all the work that’s at my house, to work on this garden but other women don’t want to do the same? [...]. That’s why I don’t like working in-group. It doesn’t work.”

Furthermore, some women mentioned that on many occasions they were not able included the decisions –making process about how to manage the initial start-up funds and the revenues generated from the cooperative parcel. Past gender-related studies in fishing communities reveal a similar picture. Djigal (2003 quoted in Bennett *et al.*, 2003), for instance, found that in coastal fishing communities in Senegal, women often formed larger associations. However, because of the significant number of members, many of them had limited access to decision-making processes within the organization. Therefore, large number of membership, combined with household responsibilities, may constrain the capacity of women to organize themselves and participate in decision-making process within the group.

Although the cooperative parcel was not sustained, several smaller gardening groups started to form since 2012. Today there are 13 such groups of 6-12 members each that are recognized by the community and external agents, and several others that exist without formal recognition (see Table 1). Women explained that for them, forming and joining these gardening groups was necessary to recruit the labor of others and accessing land with adequate access to water. In these gardening groups, women organized their labor through a daily rotation system that enabled them to collectively balance their time between their households and the garden production. Women, who are not participating in the garden on a certain day, have the responsibility of helping with household chores of those who are working in the garden.

Members of the groups are often relative and friends, which because of the preexisting kinship and ties, communication was easier and a shared sense of responsibility towards each other. Because of the smaller size groups, organizing the labor between them became more practical. They have succeeded in providing opportunities for women that they could not have achieved by themselves.

Table 9. Horticulture production characteristics for women and men in Diadieme and Zire.

Horticulture production characteristics	Women	Men
Average CH. revenue per parcel in 2015	\$979	\$2754
Parcels with at least one sourga	28 percent	58 percent
Average size CH parcel exploited	~0.4 ha.	~0.6 ha.
Number of cooperatives	2	2
Number of garden groups	13	0
Number of private parcels exploited	45	205

5.6.2. The structure

5.6.2.a. Two decades of project misfits and transforming relations

Over the last two decades, five different international NGOs implemented several livelihood projects as part of 3 major integrated fishery management programs (with 3-5 years plans) in the 18 communities surrounding the reserve. In the process, program managers brought in new forms of institutional arrangements to accommodate the implementation of their projects. These arrangements included the creation of

management committee and cooperatives. However, the tangible outcomes of these projects remain elusive and the newly formed committees and cooperatives are currently either inactive or have dissolved. Yet, both communities are replete of evidence of these projects that, a past leading member of a women cooperative described, as “always coming and going but never standing.”

During the discussions with community members, the reasons why these projects were not sustained became apparent. Many were founded on approaches that didn't articulate well with the livelihoods strategies and social relations that are characteristic of the reality and culture of community members. For example, as discussed in the previous section, the cooperative horticulture parcel for women was not sustained in part because the way members were required to organize themselves was not adapted to the daily limitations that women faced. A fisherman in Diadieme discussed these projects using a local proverb that literary translates, as “an empty bag will not stand”. He explained that program managers never take the time to understand their needs, their way of life and how they structure their social relations around their livelihood strategies. He believes that this was the pre-requisite for selecting and implementing the right “things that would make the bag stand.”

Thus the tangible outcomes of these projects have been minimal. Nonetheless, they had long lasting effects on the local social structure. The expansion of their social networks to include relationships with external actors in the rural development sector (e.g. field coordinators and local government officials) is a major advantage that many have noted to be a significant advantage of these projects. Throughout the years, they

have been connected with people who have been instrumental in individual farming productions. For instance, a young fisherman made the acquaintance of a technical agent for an NGO. He explained that even after the project ended, the agent helped him participate in a regional training session for horticulture production. This has allowed him to diversify his CH crops and becoming one of the most successful farmers in his village. Moreover, a woman talked about a development agent who helps her find someone to transport her smoked fish to larger markets. She too had met this agent during a project in her community a few years ago. As such, for many community members, these projects brought in instrumental social relations to their networks.

5.6.2.b. Economic policies and limited access to credit

Each region of Senegal is specialized in the production of a specific agricultural commodity based on its biophysical attributes (The World Bank, 2010). Various agricultural policies have been created to target these different agro-ecological regions. The Senegal River Valley, where Diadieme is located, is nationally designated for rice production. Therefore, economic policies in this region are designed to boost the production of rice and the government provides very little to no support to producers who decide to cultivate a different crop. For instance, producers can't get a loan from the regional agricultural bank to finance their commercial horticulture projects. Furthermore, by default, producers of horticultural commodities are excluded from national agricultural programs designed to connect small-scale producers to larger networks and to technical and marketing services. This has direct implications for fishing communities

in the region that, as noted earlier, for practical reasons choose CH over rice-production.

In Diadieme particularly, many fishers have noted that the lack of external support for CH activities, particularly for financial capital and technical support. One expressed this aspect in the following quote:

“You can borrow money from the bank if you want to cultivate rice, but for commercial horticulture we don’t have those capacities. You are on your own. You have to manage with the little that you have.”

Because CH producers have no access to formal credit, they often have to borrow from informal sources such as the traders or, in the case of fisher-farmers, the fish traders. These later impose high interest rates and unfair payment options, which create conditions of financial insecurity for the borrowers. Many fishers in Diadieme and Zire have reported to borrow money from fish traders to either purchase fish equipment or finance farming activities. They’ve expressed how much the amount of debt they accrue from fish traders constrains their livelihood security. For example a fishermen noted:

“All the money from the onions goes back to the coxer [trader]. If you don’t pay it all then he won’t lend you any more money. Once you repay all your debt, you are left with very little to take care of other things.”

These limitations that the fishermen in our case study face is symptomatic of broader economic conditions shaping the local level social structures (Morand *et al.*, 2010; Mills & Morand, 2009). This is a reminder that despite the agency of households to reduce vulnerability, Nygren & Myatt-Hirvonen (2009) argue that these strategies are embedded in broader economic and political structures, which they have very little control over.

5.7. Implications for Research and Practice

5.7.1. Organization of labor

The findings from this study combined with those by Geheb and Binns (1997) suggest that hiring seasonal farm workers is a common practice in African fishing communities. However, the contribution of farm workers in fishing livelihoods is missing from the fisheries literature. Yet, the allocation of labor for effective livelihood diversification has been noted as a key issue in past research (Barrett et al., 2001; Ellis & Allison, 2004; Freeman, Ellis & Allison, 2005) including some in fisheries (Allison & Horemans, 2006; Brugère et al., 2008). Furthermore, these findings raise questions about the argument that some advocates of diversification as a mechanism for sustainable resource exploitation have advanced (Ellis, 2001; Ju Larsen, 2003; Cinner et al., 2009). Their argument is based on the notion that the fisher will divert his labor to alternative occupations during a time of fish resource scarcity, thereby giving an opportunity for fish stocks to recover. However, this study proves that this is not always the case, as the fisher hires seasonal a farm worker allowing him to continue fishing even when fish stocks are low. Nonetheless, this seemed to be the case mostly for those who had not acquired enough experience in horticulture production.

There are two recommendations that can be extrapolated from these previous findings. The first one, is that further research need to be carried on the seasonal organization of labor in fishing communities, particularly as it pertains to hiring of labor, its implication on fishing activities, and enabling households to sustain a flow of income during the low fishing seasons. Second, fishery management programs plans need to

take into account the factors that shape labor relationships and the effects on resource exploitation. This can help programs managers understand and address the issues that weaken the link between diversification and lower fishing pressure. For instance, in the communities studied here, lower technical knowledge in horticultural production (due to limited experience) is a factor shaping the organization of labor. Thus providing training to those who may lack experience may strengthen the relationship between diversification and lower fishing pressure.

5.7.2. Issues related to women

The findings from this study supports the common argument that women in rural settings, particularly in Africa, face limitations in their capacity to access the labor they need to participate in economic activities (Wooten, 2003). This study, nonetheless, have uncovered some key elements in the ways women can effectively participate in farming production.

I found that women seem to have better control over their labor and accessing other resources (e.g. seeds, farm plot) when they worked in smaller groups. Yet projects managers tended to establish larger associations, which were cooperatives of 25 or more members. There are some possible explanations why larger associations were preferred. First, following the gender mainstreaming strategy in development practice (Walby, 2005), donors of these projects may require the participation of a significant number of women. However, as I demonstrated in this study, certain models of development are not always the appropriate ones. Therefore, it is important that projects targeting women

first understand the limitations of women that shape their capacity to organize themselves.

Another one would be that larger groups, as Bingen *et al* (2003) explain, may provide members more leverage in negotiating with external agents (e.g. NGOs, banks, government) to access productive assets and larger markets. In this case, it is important that projects try to form networks linking smaller women groups, like the ones in Diadieme and Zire, to larger networks of women associations.

5.7.3. Structural limitations

In this study, I found national economic policies, particularly in Senegal, constrained the capacity of fishermen to participate in horticulture production. This is because they did not have access to formal credit to finance their CH projects. As a result, they had to borrow from informal credit sources such as fish and agricultural product traders. This often places fishermen into situations of predatory-lending systems that significantly reduced their capacity to achieve income security. Several scholars such as Béné *et al.* (2009) and Morand *et al.* (2010) have explained, that non-fishery based interventions, such as providing formal access to credit, are significant in enhancing the livelihood security of fishing communities. Therefore, integrated management plans should make provisions to provide more secure and formal sources of credit to facilitate the diversification process of people in fishing communities.

5.8. Conclusions

In this paper I examined the livelihood diversification processes in two fishing communities of SRD. More specifically I studied how fishermen and women structure their social relations to access and organize the resources they need to participate in farming activities and the social structures that shape these processes. The study revealed that the careful organization of labor is central to successfully engage in both activities. As such, most social relations revolved around how to best access and structure labor. I found that the farm worker was key in this aspect, particularly for men. This study further described the different forms of relationships that between the farm worker and fisherman that were structured in ways that allowed the former to overcome his limitations. An important limitation was his limited experience related to horticulture.

Women, on the other hand, faced limitations in terms of their own labor and recruiting farm workers. Such findings support Wooten (2003) assertion of labor constraints for women in rural communities. Bennett (2005) also noted that, in fishing communities, the capacity of women to organize themselves in order to participate in economic activities was a major limitation. Nonetheless, this study reveals that women have more control over their participation in farming activities when working in smaller groups.

In addition to understanding the social relations embedded in the diversification process, this study also analyzed the ways in which the broader structure defines their participation in farming activities. I found that externally driven projects have had long lasting effects on the local structure. Many community members have acquired new

relations outside of their local social networks, which they were able to use to access resources that were instrumental to their participation in horticultural activities. Moreover, despite the effort to achieve livelihood security through diversification, community members have very little control over broader structural issues such as economic policies and limited access to credit influence their livelihood strategies. In the end I provide several recommendations that for carefully designed integrated management plans that can effectively use livelihood diversification as a mechanism for sustainable fishery systems. These recommendations include:

- Further research be carried on the seasonal organization of labor in fishing communities, particularly as it pertains to hiring of labor, its implication on fishing activities, and enabling households to sustain a flow of income and food during the low fishing seasons.
- Fishery management programs plans take into account the factors (e.g. lack of technical) knowledge that shape labor relationships and the impacts on resource exploitation.
- Diversification projects targeting women in fishing communities need to understand the limitations of women that shape their capacity to organize themselves;
- Projects can link smaller women groups to broader networks to increase their leverage in accessing productive assets such financial and technical capacity.
- Non-fishery based interventions, such as providing formal access to credit, are significant in enhancing the livelihood security of fishing communities.

CHAPTER VI

SUMMARY AND CONCLUSIONS

6.1. Summary

6.1.1. Fisheries institutions, livelihood diversification and sustainable resource exploitation in the Senegal River Delta

The first goal of this study was to examine the implementation of the two integrated management plans in order to extrapolate the institutional and socio-economic factors that help create the conditions for sustainable resource exploitation. More specifically I ask the following two questions: 1. What institutional factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation? 2. What socio-economic factors within the integrated management plan in each community shape the conditions for sustainable resource exploitation? I focus mainly on the factors that positively influence fishers' behaviors.

In order to have a focused analysis, I selected only two communities, namely Zire and Diadieme to accomplish this objective. In this chapter I focus mostly on Zire given that it is the community with stronger institutions and higher level of compliance to fishing regulations. Understanding the processes that were taking place in Zire was crucial to reach our main objective. On the other hand, Diadieme, which is the community with relatively poor institutions and the lower level of compliance to fishing regulations, was used as the “control” community. In other words the data from Diadieme was mostly used as baseline for comparison.

I used the definition of institutions as the governance functions relating to “the rules that provide exclusion, create entitlements, regulate uses, and provide for monitoring of the resource and structure participation and decision making” (Isaacs, 2011 p. 364). As such, the project examines how fishers react towards the rules that have been put in place through each protected area management system and whether or not they are compliant to these rules in each community. The degree of compliance to rules and regulations among fishers were used as a proxy for sustainable resource exploitation. I focus on the low fishing seasons since they are strict regulations to limit commercial fishing in both communities during this time. The sustainable livelihood framework, as proposed by Ellis and Allison (2001) was applied to mainly uncover the processes of livelihood diversification in each community. The framework highlights the institutional factors that mediate access to livelihood diversification resources, the household’s assets, income pooling among household members and organization of labor. All of these factors, according to Ellison and Allison (2001) influence fishers’ decisions about fishing activities at various seasons.

Regarding the institutions, the findings reveal two important factors that were present in Zire but not in Diadieme: participatory institutional arrangements that created a sense of ownership and consensus among fishers and second, institutional support for livelihood diversification of fishers. In Mauritania, the protected area is ran through a concession system with community territorial units co-managed between park officials and fishers cooperative representing different communities. The fishers’ cooperatives play a central role in the design and enforcement of rules. Park managers explain that

since the concession system were instituted along with the institutionalization of fishers' cooperative, there has been an increase sense of ownership among fishers. They further believe that it is this sense of ownership that has influenced fishers to accept and comply with fishing regulations because they feel that it is their resource to protect. Fishers also noted an overall positive relationship with park official and a strong consensus among themselves about fishing rules particularly as it pertains to commercial fishing during the low season and accessing other fisheries.

Furthermore, the cooperative support the fishing household through their diversification process by providing them seeds and financial capital that they need to engage in commercial horticulture. McCay et al. (2014) found similar results in Mexico, where the concession system in which fishers' cooperatives were very involved in the management of the local fisheries, was more effective at influencing fishers behaviors. Furthermore, Charles & Herrera (1997) also found that in the fisheries in Costa Rica, fishing cooperatives that also provided support for livelihood diversification to its members, fishers were more compliant to the rules. Therefore, this study combined with the results from these past research confirm the effectiveness of fishing access regimes that promote are not exclusionary but increases the sense of ownership and responsibility among fishers. These studies strongly support Ostrom (1990) design principles for the sustainable governance of common pool resources, including: community territorial rights and collective choice arrangements. Additionally, institutional arrangements for fisheries management should also incorporate the distribution of benefits to its members

beyond fishing related activities. More specifically they must adopt an integrated livelihood support approach for fishers.

This study also found socio-economic factors that contributed to the conditions for sustainable resource exploitation. These factors include, local livelihood strategies that are congruent with household needs, the contribution of women in sustaining household income, and livelihood diversification interventions that are aligned with pre-existing livelihoods.

First, households' access to income sources that are synchronized with household needs in terms of seasonality can help strengthen the link between diversification and sustainable exploitation of fishing resources. In other words, access to a steady income flow from alternative sources during the low fishing season incentivizes fishers to halt fishing activities when mandated. The income flow of a household depends on the combination of activities in their livelihood portfolio, their livestock holding, and the financial contribution of women. Hill et al. (2012) also noted that, in fishing communities in the Philippines, the timing and frequency of income from seaweed farming as a complementary activity accounted for the variations in fishers number when fish stock declined in various communities.

Furthermore, the results reveal that a substantial economic contribution from woman provided incentive to men to stop fishing during the low fishing season. This was the case in Zire, where women were involved not only in fish processing and trading, but also in commercial horticulture and petty trade. As a result, they contributed a significant and steady income flow by being involved in post-harvest and non-fishing

activities. It is important to highlight the involvement of women in non-fishing activities that are unaffected by seasonality because this element is essential in sustaining income flow at the household level. Gnimadi et al. (2006 quoted in Brugère et al., 2008) and Massamba et al. (2005 quoted in Burgère et al., 2008) also found that in Benin and Congo, fishers' activities stopped due to low catches when the women continued contributing to households. In these case studies women were also involved in non-fishing activities such as the commercialization of wild fruits. Thus, our results provide supplementary evidence of the range of income streams available to fishing households especially from women. Therefore the sole preoccupation of diversification policies should not be focused on providing fishers with alternative occupations, but should also encompass broader goals related to increasing the level and flow of women's income. Our finding also showed the importance of livestock in shaping fishers exploitation. In fact, fishers in Zire explained the important role of livestock holding, mainly goats and sheep, played in their livelihood security.

Finally, diversification interventions that are congruent and aligned well with local livelihoods are more effective at positively shaping fisher's behavior. Instead of introducing new alternative activities such as ecotourism, projects in Mauritania have focused on identifying and strengthening local livelihood strategies that have the greatest potential to lead to conservation outcomes and improve wellbeing.

6.1.2. Livelihood security of farming-fishers: The effects of livelihood diversification from a multidimensional perspective

The second objective of this project is to better understand why livelihood diversification helps build resilient fishing livelihoods for some households but not others. It focuses on farming as an economic activity to complement fishing during the off-season, and the factors that define its outcomes on the livelihood security of households. In doing so, this chapter presents an approach to assessing the livelihood effects of diversification that is more holistic than the ones used in past studies. This approach is based on the different dimensions of livelihood security including: income security, food and nutritional security, asset building and risks factors. For this section of the study, the data that we collected from all three communities (N=104) were used, including the socio-economic information that was gathered from the short survey, and the structured interview questions. In order to assess the effects of farming on the each dimensions of the livelihood security of fishing households we used the following criteria:

- Income security:
 - The level, frequency and timing of income from diverse activities help mitigate the mismatch between consumption needs and income levels caused by seasonality
- Assets building:
 - The level, frequency and timing of income from diverse activities help mitigate the mismatch between consumption needs and income levels caused by seasonality.

- The alternative occupation improves the human capital either through skills acquisition or direct investment into education.
- Food and nutritional security:
 - The alternative occupation enhances access to sufficient food throughout the various seasons and access to nutritious food either at the household or community level.

In addition to these important dimensions, I also examined other factors that define the outcomes of farming on fishing livelihoods including, the risks associated with both activities and the household asset holdings.

In terms of *income security*, an important condition of livelihood security is to overcome the mismatch between household consumption and uneven income flow caused by seasonality (Ellis, 1998). Thus higher income level does not always translate to income security if revenues from farming are not synchronized with household consumption needs. Our findings indicate that not all forms of agriculture are effective because of the timing and the frequency at which the revenues were collected. The timing and frequency of income depended on the crops that were cultivated and the types of assets that the households possessed. Rain-fed rice production and commercial horticulture (CH hereafter) are the two main forms of agriculture in the communities. While rice production yields substantive revenue for many fishing households, the timing and frequency of this revenue is not synchronized with their own needs. On the other hand, CH provides income for households at a time when economic returns from fishing are at its lowest. As a result the timing of income from CH corresponds with low fishing season thereby responding better to the needs of the household. Households in

Zire were the most successful at achieving income security through fishing and farming, where the only form of agriculture is CH. The diversity of horticultural crops that are cultivated is also an important factor. Households that mixed long-term high value crops with short-term lower value crops were able to collect larger and more frequent revenue.

The analysis shows that that investment into *household assets* using farming revenues was different in all three communities. This variation is mostly due to the amount of farming revenue collected and the amount of debt they accrued. Overall households that collected high farming revenues and didn't accrue substantial debt had the capacity to reinvest in the household assets that are important to maintain or improve wellbeing. However, households that were limited by debt were not able to reinvest into other resources, in which case engaging in farming did not help improve their asset base. The issue of informal debts is prominent in fishing communities (FAO, 2005; Mills et al., 2009), yet it has not been examined in the context of diversification. Our study provides evidence that high level of debts accrued from fishing material precludes positive outcomes of diversification in fishing communities. In Zire, however, households were able to invest in livestock with their farming revenues. Research shows that livestock acquisition plays an important role in lifting households out of poverty and providing safety nets to keep them from falling back into poverty (Kristjanson et al., 2004; Smith et al., 2013).

Overall, the findings reveal that rice and CH improved the *food and nutritional security* of fishers in all three communities. We found that seasonal engagement in CH improved the food security of most fishers in Zire and Diadieme by giving most fishers

the income they need to purchase food supply to last them during the months when fish stocks are low and income from fishing is not sufficient to meet minimum food consumption needs. Nevertheless, some households claimed that the amount that they received from CH was not enough to buy food supply to last them the whole 3 months when fish stocks are low. In Bountou Batt, on the other hand, seasonal engagement in CH among most fishers did not improve their food security. Most households interviewed in Bountou Batt claim that all the money they earned from MG, was used to pay debt accrued from fishing activities or used to finance their rice production, therefore they did not have enough money to buy food supply.

In terms of nutrition, engaging in CH improves the nutrition of the community overall by making nutrient-rich food such as fresh fruits and vegetables available within the villages. This is important especially for communities that are isolated and located far from the markets, like Ziré and Bountou Batt. Indeed, many fishers interviewed reported easier access to fruits and vegetables to complement their daily diet as an advantage of having horticultural parcels in the communities. This is a topic that is overlooked in the fisheries research, yet health issues are ranked amongst the most important sources of vulnerability (Béné & Russell, 2007; FAO, 2007; Mills et al., 2009). Improving access to nutritious food can be a step towards reducing health risks in fishing communities.

An important factor that affected the outcomes of farming on their livelihoods was the species that the fisher targeted. In each community, fishers targeted different types of species. This has an implication on the level of debt that these households

accrued and how they used their earnings from farming. Targeting species such as the Nile Perch (*Lates Niloticus*) requires special and expensive equipment. Fishers who chose this strategy had to borrow from fish traders to purchase the equipment. On the other hand, when fishers specialized in smaller fish species such as the catfish (*Clarias Gariepinus*), the yellow mullet (*Mugil Cephalus*) and the Nile Tilapia (*Oreochromis Niloticus*), they tended to accrue less debt from fish traders. While for some fishing households, farming was used to supplement their income from fishing, for others it was a source of financial capital to invest in their fishing equipment. These findings suggest that depending on the specialization of the fisher (i.e. target species), farming may or may not serve as a strategy to enhance the income and food security of his household.

Household level decisions about resource allocations are made based on its asset profile and capacity to access resources (Allison & Horemans, 2006). Therefore, it is also important to evaluate how the level of assets that household has in their possession influences their livelihood security. The findings reveal that livestock holding and fishing equipment that households have in their possession were important factors. Furthermore, a household's access to land, technology and manpower also affected their decisions on the diversity and types of crops they chose to farm. Household in Zire complement their fishing and farming income with livestock holding, mainly goats and sheep. They explained the importance of small livestock for their livelihood security. We found that higher investment in fishing gears translated to higher debt levels. Fishers in Zire spent relatively less money purchasing fishing equipment than the other two communities. In Diadieme, all fishers who were interviewed owned at least one boat and

used driftnets as their main fishing gear. Bountou Batt had the highest level of capital investment in their fishing activities of all three communities. Finally, fishers reported that access to land, technology and manpower determined the choices of crops they cultivated.

The perceived risks associated with farming and fishing was evaluated. In terms of farming most fishers reported debt accrued as a major concern, followed by crop failure and market prices. Fishers indicated that the level of debt accrued from the bank to finance rice production and the multiple expenses at harvest were the most significant risk factors. Furthermore, most of these fishers have experienced crop failure in the past few years and lost most of their capital investments in didn't receive any profit from this activity. Finally, market prices for horticultural commodities such as onion are the third most significant risk that fishers reported. In terms of fishing, the high variability and unpredictability of income flow due to seasonality was the highest risk. While the uncertainties associated with both livelihood activities are considerably high, an important aspect is that the risk factors for farming and fishing are different. Ellis (2000) insists that in order for diversification to reduce vulnerability, the risk factors for the different activities should not be the same

6.1.3. Between fishing and farming: Fishermen, women and processes of livelihood diversification in the Senegal River Delta

The third objective of this study is to unveil the processes that defined the participation of men and women in farming activities in fishing communities of the

Senegal River Delta. This objective is significant because policies that seek to support resilient livelihoods need to be built on a better understanding of the social processes, including people's agency (Coulthard, 2012) and the structures that shape their agency (Nygren & Myatt-Hirvonen, 2012). In this chapter, I focus on the way men and women structure their social relations to access and organize resources to participate in farming, highlighting the gender-based differences. Additionally, I describe the social structure that is shaping the diversification process of fishing-farming livelihoods.

For this objective I applied a qualitative analysis of the data collected from the semi-structured and open-ended interviews from men and women, as well as project managers. In addition, 17 women who engaged in horticultural activities were interviewed including leaders of women cooperative and garden groups. They were asked questions about the advantages of working in groups, how they access resources they need, and organize their labor. They were also asked their perceptions about the different projects that were implemented by an NGO. Secondary data was also used to complement the analysis, including statistical report from the department of inland fisheries in Senegal and other technical report from the government of Senegal and Mauritania.

I used the actor-structure framework to analyze these social processes. In this framework, agency can only function through social relations, and that structures shape and are shaped by agency (Long & Long, 1992). However, factors such as gender, race and ethnicity determine the forms in which actors interact with each other as the basis of their relations. Furthermore, the structure constitutes the contextual factors at different

levels that interact with individual's agency and the outcomes of their livelihood strategies (DeHaan, 2012).

For rural households, an effective organization of labor is a key element to livelihood diversification (Ellis, 2000). According to Martin *et al.* (2013), there are inevitable trade-offs between fishing and farming in terms of labor time, which causes risks to people's livelihood security. The findings from this study revealed that the relationship between the fishermen and the farm worker (sourga – hereafter) is the foundation of an optimal organization of labor that is centered on the former's daily needs and level of experience in farming production. In Zire about 40% (16 out of 40) of fishermen engaged in CH hired 1 to 4 sourgas and all as laborers. In Diadieme, all participants who were interviewed hired 1 to 2 sourgas and 70% (31 out of 44) of those used them as farm laborers. CH productions are twice higher in parcels that had at least one sourga and three times higher in those with at least two sourga. The role of the sourga on the farm has implications on how the fishermen allocate their time between the two activities. If the sourga is hired as the farm manager, the fisherman was able to continue fishing. However, if the sourga is hired as a laborer then the farm owner, the fisherman in this case, supervises the operations and had to spend more time on the farm (thus decreasing time spent on the lake).

Geheb and Binns (1997) note that in fishing communities around Lake Victoria, farm workers “relieved them [fishers] from farming duties and permitted their greater concentration on fishing” (p. 89). To our knowledge, the previous study is the only one this aspect is evoked. Our findings provide strong evidence of the different forms of

relationship between the fisherman and the farm worker and how they are structured around the limitations that the former encounters in the diversification process.

There is a gender dimension to the process of diversification. In this study, findings reveal that even though women were not directly excluded from participating in horticultural production, they had little control over labor, including their own and that of others. Unlike men, women typically rely on a male household member to find them a reliable sourga. Some reported that they could not participate in horticulture production because they couldn't find a sourga. Some reported that they could not participate in horticulture production because they couldn't find a sourga.

As mentioned previously, women have very little control over their own labor, especially because of the amount of housework they have to do. As such, women have to restructure their relations around the labor constraint that they face everyday. Smaller women garden groups of 6-12 members, rather than larger cooperative of 25 members or more, proved to be a better fit for women in these communities. Women explained that forming and joining smaller gardening groups was necessary to recruit the labor of others. As such, groups members organized their labor through a rotation system in that allows them participate in gardening activity and taking care of their households at the same time.

There are several structural factors shaping the participation of men and women into farming activities. The most direct ones is the fact that for over two decades, there's been several external interventions from NGOs and local government to implement livelihood projects. Although the tangible outcomes of these projects have been minimal,

they have greater effects on the social structure within which community members participate in different economic activities. The expansion of their social networks to include relationships with actors in the rural development sector is a major advantage that many have noted to be a significant advantage of these projects. Throughout the years, they have been connected with people who have been instrumental in individual farming productions.

Second, economic policies have placed limitations on the capacity of fishing communities to diversify into commercial horticulture. Economic policies in this region are designed to boost the production of rice and the government provides very little to no support to producers who decide to cultivate a different crop. Many fishers have noted that the lack of external support for CH activities, particularly for financial capital and technical support. This is a reminder that despite the agency of households to reduce vulnerability; their livelihood security is embedded in broader economic and political structures, which they have very little control over.

6.2. Conclusions

The overall goal of this study was to understand how local livelihood diversification strategy could best be combined with fishing policies and practices to promote sustainable inland fishery. Through the process, I sought to generate knowledge on the following aspects: 1. What institutional and household level factors influence fishers' decisions about how to exploit fishery resources? 2. The effects of livelihood diversification on the livelihood security of fishing households. 3. The social

processes that shape how men and women in fishing communities engage in livelihood diversification. Each of these aspects are covered in three different chapters. In order to attain this goal, I used the case study of three fishing communities around the Transboundary reserve of the Senegal River Delta, located in Senegal and Mauritania.

In the past 30 years the SRD have gone under serious ecological transformations. These ecological mutations combined with unsustainable fishing practices in the region have seriously reduced the fish productivity in the river system. As such, the government of Senegal and Mauritania have established the Transboundary Biosphere Reserve of the Senegal River Delta to protect these important resources. These environmental changes and conservation policies have drastically curtailed access to fishery resources for the communities around the reserve (Fall et al., 2003; Magrin & Seck, 2009). Since 1994, several integrated management plans for the biosphere reserve have been put in place.

While these management plans have had some success, unsustainable fishing activities within the reserve continue to be a major concern and fishing communities continue to grapple with high levels of poverty (Borrini-Feyerabend et al., 2010). Thus the motivation of this dissertation was to inform carefully designed integrated fisheries management plans in order to effectively balance livelihood diversification with fishery conservation goals.

This research is founded on a better understanding of local adaptation strategies that fishing communities have adopted as a result of several decades of environmental and social changes in the region. It focuses on the participation in fishing and farming as, respectively primary and secondary activities within the livelihood portfolios of

households in the SRD. By focusing on local adaptation strategies, this project provides valuable information on how local level processes can accommodate management programs. Furthermore, it helps us better understand the factors that strengthen or weaken the relationship between livelihood diversification and sustainable fishery management.

Scholars have noted the importance of combining institutions and livelihood diversification to promote sustainable fishery systems (Seivenan et al., 2005; Brugère et al., 2008; Hill et al., 2012; Isaacs, 2012). However, very few studies have examined integrated management plans that have taken such an approach and the conditions under which they would lead to sustainable resource exploitation. In this project, I first sought for sustainable fisheries exploitation when management institutions and livelihood diversification are combined into one integrative approach.

First in terms of institutions, institutional arrangement centered on fishery concession systems with territorial units allocated to different communities are most effective in promoting sustainable resource exploitation. The study shows that such forms of institutional arrangements can promote a sense of resource ownership and consensus among fishers on how to exploit resources. This confirms Ostrom (1990) principle of common property resource management such as: Community has territorial rights to resource systems; and the rights to make the rules and to enforce them through viable mechanism. Furthermore, this study shows that implementing an effective livelihood diversification strategy can also strengthen this relation. This entails providing institutional support for local diversification practices. Therefore, institutional

arrangements for fisheries management should also incorporate the distribution of benefits to its members beyond fishing related activities. More specifically they must adopt an integrated livelihood system approach for fishers and the resources on which they depend.

Overall, the study finds three socio-economic factors that contributed to the conditions for sustainable resource exploitation. These factors include, local livelihood strategies that are congruent with household needs, the contribution of women in sustaining household income, and livelihood diversification interventions that are aligned with pre-existing livelihoods. Therefore, diversification policies should not be solely focused on providing fishers with alternative occupations, but should also encompass broader goals related to increasing the level of income flow and the participation of outside of the fishery sector. Finally, I also suggest that in order to create the right socio-economic conditions, future integrated fisheries management plans also focus on: promotion of diversification strategies that are congruent with household needs and that integrate easily within locally preferred livelihoods and increasing the level and flow of women's income

A second objective of this project was to understand the effects of farming as a diversification strategy on the livelihood security of fishing households. First in terms of income security, commercial horticulture, rather than rice production, is more effective at providing timely source of income that is congruent with household needs. In addition to improving income and food security, commercial horticulture improves the nutrition of the community overall by making nutrient-rich food such as fresh fruits and

vegetables available within the villages. This is a topic that is overlooked in the fisheries research, yet health issues are ranked amongst the most important sources of vulnerability (Béné & Russell, 2007; FAO, 2007; Mills et al., 2009). Improving access to nutritious food can be a step towards reducing health risks in fishing communities. Other factors that impacted households' achievement of livelihood security though diversification include, the amount of debt that household accumulate, the fish species that are targeted and access to land technology and manpower Higher livestock holding strengthen the relationship between diversification and livelihood security. Interventions focused on reducing risks associated with farming will be effective in enhancing the livelihood security of fishing households.

Finally, the third objective of this study was to unveil the social processes that shape the participation of men and women in farming activities in fishing communities of the Senegal River Delta. In order to effectively combine fishing and farming activities, men and women structured their social relations in ways that allowed them to access and organize the resources they needed to successfully combine fishing and farming activities.

The study revealed that the careful organization of labor is central to successfully engage in both activities. As such, most social relations revolved around how to best access and structure labor. I found that the farm worker was key in this aspect, particularly for men. The role of the sourga on the farm has implications on how the fishermen allocate their time between the two activities. The results of this study combined with others weaken the argument advanced by advocates of diversification.

Their argument is based on the notion that as fishers have access to alternative occupations, they will divert their labor time from fishing to other activities as fish stocks decline.

Women, on the other hand, faced limitations in terms of their own labor and recruiting farm workers. Even though women were not directly excluded from participating in horticultural production, they had little control over their own labor (e.g. tending to children and taking care of household) and had less latitude in recruiting farm workers. Nonetheless, this study reveals that women have more control over their participation in farming activities when working in smaller groups.

In addition to understanding the social relations embedded in the diversification process, this study also analyzed the ways in which the broader structure defines their participation in farming activities. Externally driven projects have had long lasting effects on the local structure. Many community members have acquired new relations outside of their local social networks, which they were able to use to access resources that were instrumental to their participation in horticultural activities. Moreover, despite the effort to achieve livelihood security through diversification, community members have very little control over broader structural issues such as economic policies and limited access to credit influence their livelihood strategies. This is a reminder that despite the agency of households to reduce vulnerability, their livelihood security is embedded in broader economic and political structures, which they have very little control over.

6.3. Key Lessons Learned

Throughout this study I was able to extrapolate some key lessons for research and practices. The key lessons include:

- a) Integrated fishery management plans should be founded on a better understanding of the fishing livelihoods including: the factors that influence the decisions about resource exploitation, how fishers react to fishery institutions, and the processes that enable them to participate in alternative occupations, particularly farming.

- b) Future integrated management plans for fisheries need to make provisions for the following factors: increase the frequency of income from alternative occupations, increase the level and flow of women's income and build household asset focusing on livestock as a form of savings. Focusing on these elements can address some of the issues that often debilitate the linkage between livelihood diversification and the sustainable exploitation of fisheries. Furthermore, these should be combined with the presence of institutions whose programs promote a sense of ownership and consensus among fishers as mechanism to strengthen the previous relationship.

- c) Diversification interventions that are focused on pre-existing livelihood strategies can be more effective at strengthening the conditions for resource stewardship. This is contrary to interventions that are focused on introducing new forms of livelihoods such as ecotourism.

- d) Even though farming reduces the poverty of fishing households, this form of diversification does not necessarily lead to more secure livelihoods. It is important that future research on the effects of diversification not focus on it only as a poverty alleviation tool. Diversification should be treated as a mechanism to reduce vulnerability to changes in natural and build resilient livelihoods. Therefore, examining the effects of diversification on the livelihood security of fishing households is more effective. This approach should be multidimensional and based on the dimensions of livelihood security. This allows a better understanding of the factors that explain why some households remain vulnerable to fishery fluctuations.
- e) Women activities outside of the fisheries sector support sustainable fishery systems in two ways. First, they help maintain a steady flow of income to the household. This in turn provides an incentive to fishers to halt fishing activities when fish stocks are low. Therefore, fishery management plans should not be solely focus on providing alternative occupations to fishers. They must also provide a broader range of occupations to women that are outside the fishery sector. This will ensure that household income is sustained even when economic returns from fishing are low.
- f) There are gender-based differences in the way women and men participate in farming activities as a livelihood diversification strategy. As such, projects must account for these differences in order to implement projects that are congruent with

the daily reality of women and men and the ways they organize their resources (e.g. labor, access to credit, land). This will ensure that these projects are sustained for longer periods of time.

- g) In some communities, women have more control over their labor and better access to decision-making process in smaller collective settings. However, larger organization may provide more leverage to its members in terms of negotiating with external agencies (e.g. NGOs, banks, government) access to productive assets. When this is the case, linking these smaller groups of women to broader networks of associations could be a better strategy.

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